ONTARIO HYDRO'S PLAN
TO SERVE CUSTOMERS'
ELECTRICITY NEEDS

ENVIRONMENTAL ANALYSIS

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EXECUTIVE SUMMARY

In any assessment of future industrial developments, concern for the environment will continue to be a top priority. The implementation of a demand/supply plan will have both positive and negative effects on the natural and social environment in Ontario.

No single demand/supply plan can both meet future energy needs and avoid the full range of environmental issues. Ultimately, any plan must balance advantages and disadvantages and requires trade-offs in order to reach an acceptable, effective solution.

From a technical as well as an environmental standpoint, there are many complex choices and combinations (technologies, timing, etc.) which have to be considered in selecting a plan. This document identifies and describes the potential natural and social environmental effects of demand/supply plan alternatives, and provides an assessment of their advantages and disadvantages.

Environmental Analysis

This environmental analysis has been prepared in support of Ontario Hydro's Demand/Supply Plan. Approval of the requirement and rationale for certain plan components is being requested under Ontario's Environmental Assessment Act.

The analysis consists of three major components: development of environmental criteria; a comparative analysis of alternative demand/supply plans; and a summary of environmental advantages and disadvantages.

The environmental criteria are grouped as follows:

Natural Environmental Criteria

Resource Use
Non-renewable resources
Land use
Water use

Emissions/Effluents/Waste
Atmospheric emissions
Aquatic effluents
Solid waste production

Social Environmental Criteria

Socio-economic Effects
Regional employment
Regional economic development
Local community impacts

Societal Considerations
Social acceptance
Special/sensitive groups
Lifestyle impacts
Distribution of risks and benefits

Alternative plans are analyzed in three stages: Initially, there is a discussion of the potential

environmental effects associated with common elements, i.e., those components which are included in all plans. The common elements include:

Demand management
Non-utility generation
Hydraulic generation
Station rehabilitation
Manitoba purchase

Secondly, the report evaluates the differences among the alternative major supply options and Cases. It discusses potential environmental effects, together with potential mitigation and/or compensation for dealing with any anticipated adverse effects.

Finally, the study concludes with a summary of the advantages and disadvantages of each plan, from the perspective of the natural and social environmental effects likely to occur.

All plans reflect a serious commitment to mitigating and controlling environmental effects. In addition, the plans contemplate that additional demand management programs, and the use of renewable resources for electricity generation, will continue to be given high priority. However, there are residual environmental effects that are evident by the end of the planning period. These include continued use of non-renewable resources, water and land, emissions of acid gas and CO_2, and production of solid waste. All plans also offer a range of potential social benefits, including increased employment and regional development opportunities. Potential adverse social effects relate to localized community impacts associated mainly with the supply components of a preferred plan.

Ongoing efforts by Ontario Hydro in the following areas will provide opportunities to further reduce residual effects:

- Research and development to facilitate application of best available control technology at existing and new stations to provide continuing reductions in overall system emissions and afford a wider operating margin with respect to existing and anticipated regulations;
- Regular re-evaluations of the trade-offs associated with advancement of the phasing of IGCC or other clean coal technologies, with a view to further reducing acid gas and CO_2 emissions, and waste volumes, over the long term;
- Continued and expanded commitment to waste re-use and recycling programs, particularly in the area of fossil combustion and emission control wastes;
- Continued and expanded commitment to water re-use and recycling to reduce consumptive water use and reduce discharges to Ontario waterbodies;
- Continued and expanded support for waste heat utilization projects (e.g., aquaculture) to reduce thermal discharges to the environment;
- Continued and expanded commitment to promoting compatible uses of land at generating stations and along rights-of-way;
- Continued and expanded commitment to reforestation efforts to offset vegetation losses due to hydraulic flooding and transmission right-of-way clearing. This has ancillary benefits of increasing the CO_2 absorbing vegetative sink in Ontario and providing local employment opportunities;
- Continued commitment to public consultation and community impact management in dealing with potentially affected individuals and communities.

Implementation of these measures will involve weighing their benefits against financial and other societal considerations, to ensure that an appropriate balance is struck between Ontario's electricity use and its desire to maintain a high level of environmental quality.

Conclusions

Nine conclusions can be drawn from the environmental analysis:

General

- None of the alternative plans is clearly superior with respect to all natural and social environmental criteria.
- Achieving acceptable environmental effects for the alternative plans will require careful siting, design, construction, and mitigation measures for the various plan components. Project environmental assessments will address these factors.

Common Elements

- The high priority common elements in the plans generally reduce the need for future major supply and promote the utilization of renewable resources.

Demand management options are generally favoured from an environmental viewpoint, since the focus of these programs is on using energy more efficiently, thereby reducing energy use for the same level of service.

Hydraulic generation, certain types of non-utility generation, and the Manitoba purchase provide the only true renewable energy sources utilized in each plan. There will, however, be environmental effects associated with pursuing these options. Environmental assessments will be carried out, as required, to ensure that these projects are implemented in an environmentally acceptable manner.

Hydro's continuing efforts to increase the contribution from the common elements, particularly those related to demand management and renewable resource use, are important for increasing the plans' long-term environmental sustainability and social acceptance.

Major Supply Cases

- Front-end fuel cycle impacts (i.e., mining) significantly affect the wastes produced and amount of land utilized by each plan. Most of these impacts are beyond the direct control of Ontario Hydro. It is assumed, however, that these activities will be regulated to meet appropriate environmental standards, and that the costs of any remedial measures (e.g., site management and reclamation) are reflected in the price of purchased fuels.
- Nuclear-based Cases tend to have the lowest system non-renewable resource use, atmospheric emissions, and total waste production. However, they produce higher amounts of radioactive waste, and utilize higher quantities of water. While these radioactive emissions/wastes are well managed, they represent a source of public concern.
- Fossil-based Cases tend to have the lowest radioactive waste production and water use. However, they consume the highest quantities of non-renewable resources and produce significantly higher acid gas and CO_2 emissions, and waste volumes. While these Cases meet current regulatory limits on emissions and wastes, problems like acid rain and the greenhouse effect are a source of public concern.
- A Case that utilizes a mix of both fossil and nuclear generation provides a "middle ground" in that it has an intermediate level of non-renewable resource use, atmospheric emissions, water use, aquatic effluents, and waste production. However, public concerns related to both forms of generation will have to be reconciled.
- Regulations related to the environment are expected to tighten, requiring reduced emission levels and increased levels of control. Meeting these regulatory limits will be more difficult for the fossil-based Cases, particularly under upper load growth.
- There are residual environmental effects. Ontario Hydro is committed to pursuing a variety of measures which offer the potential to further mitigate the residual environmental effects of the Demand/Supply Plan.

1.0 INTRODUCTION

The purpose of this environmental analysis is to identify and compare major environmental characteristics of the alternative demand/supply plans, comment on any significant differences, and provide a broad analysis of their comparative environmental advantages and disadvantages.

This analysis has been prepared in support of Ontario Hydro's Demand/Supply Plan Report. Material from this report is summarized in Chapters 14, 15, and 17 of the Demand/Supply Plan Report and in the Analysis Report.

Approval of the requirement and rationale for certain plan components is being requested under the Environmental Assessment Act. Subsequent project environmental assessments will ensure that these components are located and implemented in an environmentally acceptable manner, and with opportunities for community input.

The Demand/Supply Plan Report documents alternative demand/supply plans developed to meet the electricity requirements of Ontario to 2014. It is the third stage of a planning process that began with the Demand/Supply Options Study (Ontario Hydro, 1986b) in 1986. This study was followed by a draft Demand/Supply Planning Strategy (Ontario Hydro, 1987d) which was reviewed by a Select Committee of the Legislature in 1988. The Select Committee's recommendations (Select Committee, 1988) are reflected in the approved Demand/Supply Planning Strategy (Ontario Hydro, 1989a), released in March, 1989. The strategy describes the planning principles and criteria, Figure 1–1, used to develop and evaluate demand/supply options and plans.

This environmental analysis supports a number of the General Strategic Principles outlined in the Demand/Supply Planning Strategy. These principles call on Hydro to:

- take a leadership role in protecting the environment and encouraging the social benefits associated with its activities;
- meet environmental requirements and standards;
- consider social acceptance;
- consider environmental characteristics and other social considerations which may influence the recommended plans; and
- include the cost of meeting social and environmental requirements in cost evaluations of demand/supply options.

Along with comparing the effects of alternative plans, this analysis:

- identifies environmental characteristics and social considerations for each technology option;
- discusses appropriate mitigation and compensation measures; and
- identifies the advantages and disadvantages of alternative plans.

The Environment Affected

The Demand/Supply Plan could potentially affect all parts of Ontario and have some impact outside the province.

Figure 1-1 **Demand/Supply Evaluation Criteria**

Demand/Supply Planning Strategy

↓

The primary criteria (which must be met) for evaluating and developing recommended plans are:

- customer satisfaction
- reliability standards
- safety requirements and standards
- environmental requirements and standards (worker and public)
- low cost of electricity service
- social acceptance
- technical soundness
- flexibility

Secondary criteria, which are considered and may influence the recommended plans, include:

- resource preferences
- diversity
- resource smoothing
- environmental characteristics (in addition to requirements and standards)
- public safety characteristics (in addition to requirements and standards)
- economic impact
- other social considerations

↓

Demand/Supply Plan

Within Ontario, the success of demand management programs and the distribution of additional sources of supply, including associated transmission, will vary regionally. For example, for large, centralized nuclear and fossil generation, cooling water requirements dictate that they be sited on the Great Lakes. Remaining hydraulic projects are mainly located in northern Ontario.

Obvious regional differences exist within the province. Southern Ontario is characterized by high population densities, moderate climatic conditions, a reliance on industrial/commercial/agricultural activity, large numbers of competing uses for a limited, privately-owned land base, and few undisturbed natural areas.

Conversely, northern Ontario is characterized by lower population densities, more severe climatic conditions, a reliance on resource-based industry and tourism, and a large Crown-owned land base having a significant proportion of natural areas.

In addition to these regional differences, there are other characteristics of the Ontario environment considered. For example, there is an established government objective of maintaining high environmental quality throughout Ontario. This is reflected in environmental regulations and standards governing industrial and other activities. The existing and anticipated regulatory framework is an important part of the operating environment and as such is considered in the development of any demand/supply plan.

The availability of reliable and reasonably priced electricity has become an accepted part of the existing environment in Ontario. In a number of instances, changing industrial processes (e.g., in the pulp and paper and steel making sectors) to take advantage of electrotechnologies has increased process efficiencies and economies and, at the same time, improved environmental quality in Ontario.

The nature of the Bulk Electrical System (BES) itself is a critical part of the environment that will be affected by this undertaking. Hence, certain limitations of the existing BES need to be addressed. For example, maintaining a regional balance between demand and supply is an important principle governing future system development. BES considerations are discussed more fully in the Plan Report.

Certain components of the plan will also affect areas outside Ontario. For example, there are environmental effects outside Ontario related to purchases of fossil fuels in the US (mainly coal) and Western Canada (low-sulphur coal and natural gas). The purchase of power from neighboring utilities will also have associated environmental effects. For example, the purchase from Manitoba will require additional hydraulic development in the Nelson River area and new or upgraded transmission interconnections with Ontario Hydro's Bulk Electrical System.

This broad environmental context has been assumed and incorporated into the development of criteria and in this environmental analysis.

The environmental analysis report is organized as follows:

- Section 2.0 contains a description of the alternative plans.

• Section 3.0 provides a description and rationale for the method of analysis, as well as a discussion of the natural and social environmental criteria which were developed to evaluate the plans.

• Section 4.0 describes the potential environmental effects of the common elements in all the alternative plans, (i.e., demand management, non-utility generation, hydraulic generation, station rehabilitation, and the Manitoba purchase) and associated potential mitigation and compensation measures.

• Section 5.0 discusses the potential comparative environmental effects of major supply components of each Case and associated mitigation and compensation measures. Sensitivity to changes in load growth, planning period, siting, and regulatory changes are also discussed.

• Section 6.0 provides an overall assessment, highlighting natural and social environmental advantages and disadvantages of the alternative plans, the residual effects of these plans, and the conclusions of this analysis.

2.0 DESCRIPTION OF ALTERNATIVE PLANS

To assist in the selection of a Demand/Supply Plan, a number of alternative plans were developed to demonstrate and assess the range of acceptable options available to meet Ontario's electricity needs over the next 25 years.

These alternative plans are discussed in Chapters 15 and 17 of the Plan Report.

2.1 Common Elements

As noted previously, certain options are common to all plans. These common elements are included in all of the alternative Demand/Supply Plans before adding new major supply facilities is considered. The Demand/Supply Planning Strategy, DSPS, calls for the maximum economically achievable contributions from each of the common elements, thereby reinforcing government and corporate goals of maximizing energy efficiency and utilizing renewable resources. The common elements include:

- Demand management – programs related to end-use energy efficiency improvements as well as load shifting.
- Non-utility generation (NUG) – future NUG contributions will likely come from private hydraulic developments (less than 10 MW) and gas-fired cogeneration projects. Less than 10 percent of cogeneration projects are likely to use alternative fuels such as waste wood or municipal solid waste.
- Hydraulic generation – future hydraulic generation will be derived from new sites and redevelopment of some existing sites to take fuller advantage of available flows. Most of the remaining undeveloped potential is in the Moose River basin in northeastern Ontario and at Sir Adam Beck G.S. on the Niagara River (see list of sites in Appendix B).

The Select Committee on Energy (1988) has recommended that, "remaining economic hydroelectric sites should be developed in an orderly and environmentally appropriate manner" and that, "available hydraulic sites should be developed to maximize positive economic and social impacts to Ontario and Canadian economies in an orderly fashion. Such developments should also be designed and operated to provide positive economic spinoffs and employment opportunities, particularly in more remote parts of the province".

- Station Rehabilitation – rehabilitation will take place at many stations within the Bulk Electrical System. At hydraulic stations, dam safety will be assessed and opportunities to upgrade facilities to take fuller advantage of available flows will be undertaken. At nuclear stations, retubing activities are planned. At fossil stations, rehabilitation programs are planned for Lakeview, Lambton and Nanticoke generating stations during the 1990s to ensure these stations operate reliably over their full service life.
- Manitoba Purchase – starting in 2000, all plans assume that a firm purchase of 1000 MW will be in-place from Manitoba. The power

will be delivered from new hydraulic generation at the Conawapa site on the Nelson River in northern Manitoba, and requires major upgrades of interconnections between Ontario's West System and Manitoba. About 1100 km of new high voltage transmission line will be required in Ontario.

2.2 Major Supply Cases

Figure 2–1 provides a summary of five different mixes of generation options. These combinations of major supply options, called Cases, were selected from dozens of Cases formulated to illustrate alternatives or pursue improvements.

Siting assumptions and associated transmission assumptions for each Case are discussed in Sections 2.3 and 2.4.

Major Supply Terminology

The following terminology is used to describe options within the Cases:

CSC refers to conventional steam cycle coal-fired generation.

CANDU refers to nuclear generating stations (Canadian Deuterium Uranium).

CTUs (Combustion Turbine Units) are used to meet peaking requirements. To protect against the possibility of higher than forecast fuel prices or higher CTU capacity factors, provision is made to develop some of these CTUs, in phases, into combined cycle (CC) or integrated gasification combined cycle (IGCC) units.

These provisions make it necessary to make the following distinctions:

CTU/G – a general term covering all CTUs;

CTU/NC – CTUs with no provision for conversion;

CTU/CC – CTUs convertible to CCs;

CTU/IGCC – CTUs convertible to CC and IGCC units.

Each Case requires differing numbers of generating units and stations. It is necessary at times to describe the number of stations required and the number, timing and capacity of the generating units at any station.

This will be done as follows:

- Letters indicate the order in which stations of a particular option are employed, i.e., CANDU A is the first station, CANDU B is the second station.
- The units in stations of a particular option are numbered consecutively, i.e., CANDU A 1 – 4, CANDU B 5 – 8, CANDU C 9 – 10.
- For fossil options, the symbol Ce is introduced before the unit numbers. Ce means Capacity Equivalent, i.e., CTU/NC A Ce 1 – 4 is the first CTU/NC station, with four 150 MW units, or different size units equivalent to 600 MW capacity.

The five Cases have varying mixes of fossil and nuclear generation:

- Case 15 – mixed reliance on nuclear and fossil generation;
- Case 26 – heaviest reliance on fossil generation;
- Case 23 – heaviest reliance on nuclear generation;
- Case 24 – between 15 and 26;
- Case 22–between 15 and 23.

Case 15

In this Case, about two-thirds of new capacity under each load forecast condition consists of purchases and base load nuclear generation, the remaining one-third is peaking fossil generation. Table 2–1 summarizes capacity additions.

Figure 2–1 **Alternative Cases – Energy Production by Source**
Median Load Forecast

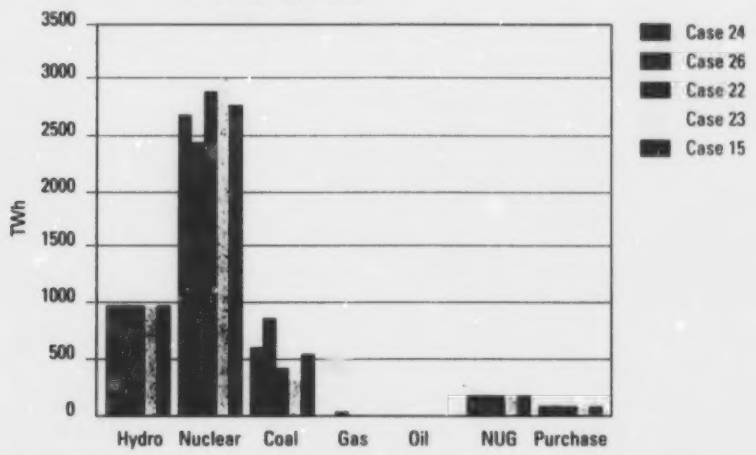


Figure 2–2 illustrates the approximate timing of major supply additions under the three load forecast paths.

Under the median load forecast, base load is supplied by nuclear generation, with in-service dates set by cost and environmental considerations. The intermediate requirement is met by existing fossil stations, retrofitted as necessary, to meet environmental requirements. The remaining peaking requirement is met with gas-fuelled CTUs, convertible to CCs or IGCCs. In total, by 2014, this Case requires ten CANDU units at three stations, six CTU/CCs at one station and 26 CTU/IGCCs at three stations.

Under the upper forecast, options are advanced in the early years to the extent permitted by lead times. In later years, in-service dates are set by cost and environmental considerations. CTU/NCs at existing stations are used to reduce capacity shortfalls in the mid 1990s. These are followed by CTU/IGCCs on new sites starting in the late 1990s. More base load nuclear is added in later years to restore an appropriate mix of generation. In total, by 2014, this Case requires 14 CANDU units at four stations, ten CTU/NCs at three stations, 12 CTU/CCs at two stations, and 16 CTU/IGCCs at two stations.

Under the lower forecast, requirements are met with fewer and later nuclear units and CTUs, whose in-service dates are set by cost and environmental considerations. The exception to delayed in-service dates is the Manitoba Purchase, for which contract commitments have been made. This Case requires, by 2014, six CANDU units at two stations, six CTU/CCs at one station, and 14 CTU/IGCCs at two stations.

Table 2–1 Major Supply Additions by 2014
Case 15

	Capacity (GW)		
Major Supply Option	Lower Forecast	Median Forecast	Upper Forecast
Utility Purchase	1.0	1.0	1.0
CANDU	5.3	8.8	12.3
CTU/NC	0	0	1.7
CTU/CC	1.0	1.0	2.0
CTU/IGCC	2.3	4.4	2.7
Total	9.6	15.2	19.7

Case 26

In this Case, about half of the new base load capacity under each load forecast condition consists of purchases and CSC coal. Peaking requirements are met by CTU/Gs. The proportion of peaking generation is larger than in Case 15, because the CSC coal station is smaller than a nuclear station and more CTUs are installed to compensate. Table 2–2 summarizes capacity additions by 2014.

An alternative to Case 26 was developed using IGCC stations rather than CSC coal stations as base load fossil generation. The results of the two Cases are similar, except for solid waste and technical soundness. IGCC features lower solid waste. CSC is more technically proven.

The approximate timing of capacity additions over the planning period is shown in Figure 2–3.

Under the median forecast, base load requirement is met with CSC coal generation. The intermediate requirement is met by existing fossil stations, retrofitted with emission controls, to meet environmental requirements. The remaining peaking requirement is met with gas fired CTUs convertible to CCs or IGCCs. This Case requires, by 2014, ten CSC Coal units at three stations, six CTU/CCs at one station, and 34 CTU/IGCCs at three stations.

Under the upper forecast, options are advanced in the early years, to the extent permitted by lead times; in later years they are advanced to the extent permitted by cost. CTUs at new stations are advanced more than CSC Coal units, because of their shorter lead times. The remaining requirement is met with very short lead time CTU/NCs on existing stations. This Case requires, by 2014, 14 CSC coal units at four stations, eight CTU/NCs at two stations, 12 CTU/CCs at two stations, and 30 CTU/IGCCs at three stations.

Under the lower forecast, requirements are met with fewer and later CSC coal units and CTUs. The Manitoba Purchase is not delayed, because contract commitments have been made. This Case requires, by 2014, six CSC coal units at two stations, six CTU/CCs at one station, and 18 CTU/IGCCs at two stations.

Major Supply Additions by 2014
Case 26

	Capacity (GW)		
Major Supply Option	Lower Forecast	Median Forecast	Upper Forecast
Utility Purchase	1.0	1.0	1.0
CSC - Coal	4.5	7.4	10.4
CTU/NC	0	0	1.4
CTU/CC	1.0	1.0	2.0
CTU/IGCC	3.0	5.7	5.0
Total	9.5	15.1	19.8

Major Supply Additions by 2014
Case 23

	Capacity (GW)		
Major Supply Option	Lower Forecast	Median Forecast	Upper Forecast
Utility Purchase	1.0	1.0	1.0
CANDU	8.8	14.1	15.9
CTU/NC	0	0	1.3
CTU/CC	0	0	0
CTU/IGCC	0.3	0	1.3
Total	10.1	15.1	19.5

Case 23

In this Case, more than 85% of new capacity under each load forecast consists of purchases and base load nuclear generation. The remaining requirement is met with peaking fossil generation provided by existing fossil stations. Some fossil peaking generation is added, mostly under the upper load forecast. Table 2–3 summarizes capacity additions by 2014.

The approximate timing of capacity additions over the planning period is shown in Figure 2–4.

Under the median load forecast, nuclear generation eliminates the need for new peaking fossil and minimizes the use of existing fossil generation. In-service dates of nuclear units are scheduled to meet all base load requirements and some intermediate requirements. Existing fossil generation moves toward the peaking role and no new peaking generation is required. In total, by 2014, 16 CANDU units at four stations are required.

Under the upper load forecast, CTUs are added in the early years, both at existing stations and at a new station. Additional nuclear units are added in later years. This Case requires, by 2014, 18 CANDU units at five stations, eight CTU/NCs at two stations, and eight CTU/IGCCs at one station.

Under the lower load forecast, fewer and later nuclear units are required. This Case requires, by 2014, ten CANDU units at three stations, and two CTU/IGCCs at one station.

Case 24

This Case is between Case 15 and the Case 26. All peaking, all intermediate and part of the base load requirements are met by fossil generation.

Under the median load forecast, base load requirements are met, in turn, by CANDU A,

Figure 2–2 **New Major Supply** Case 15

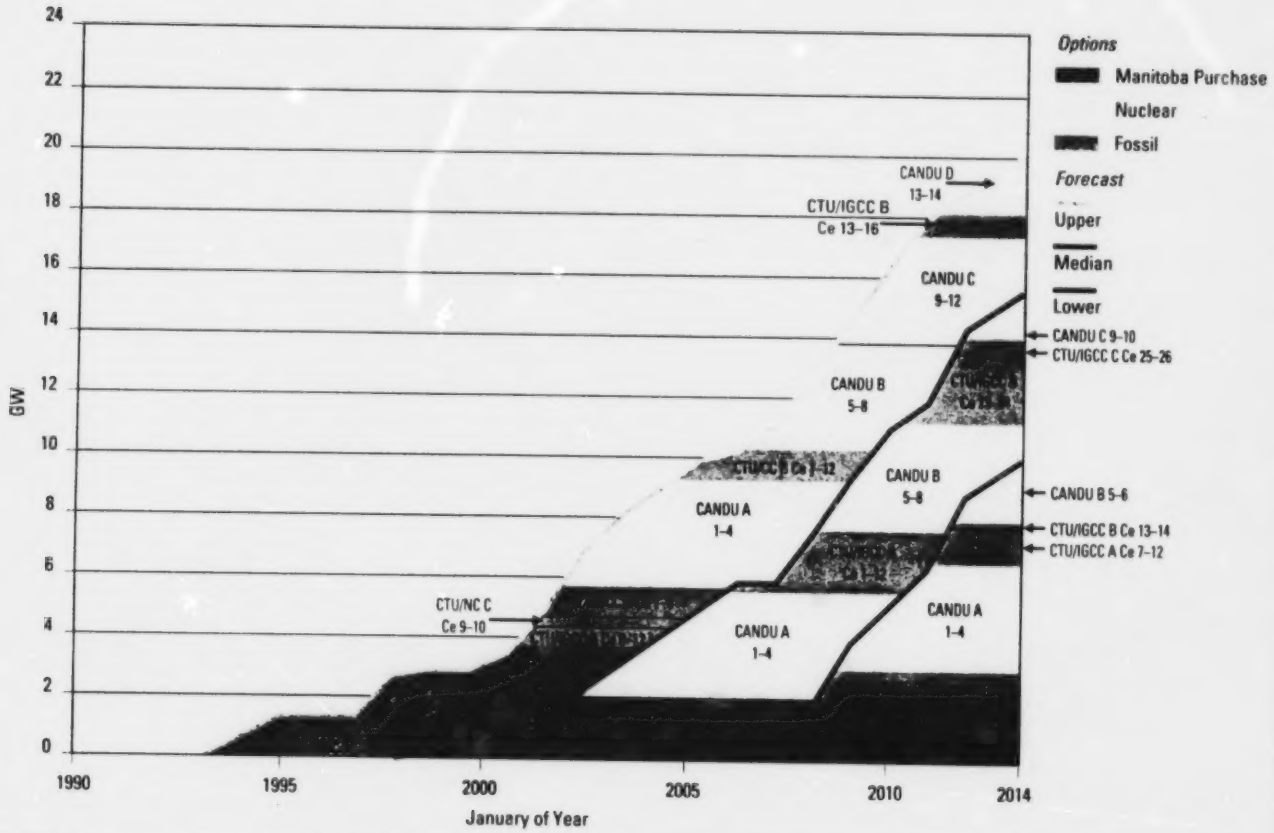
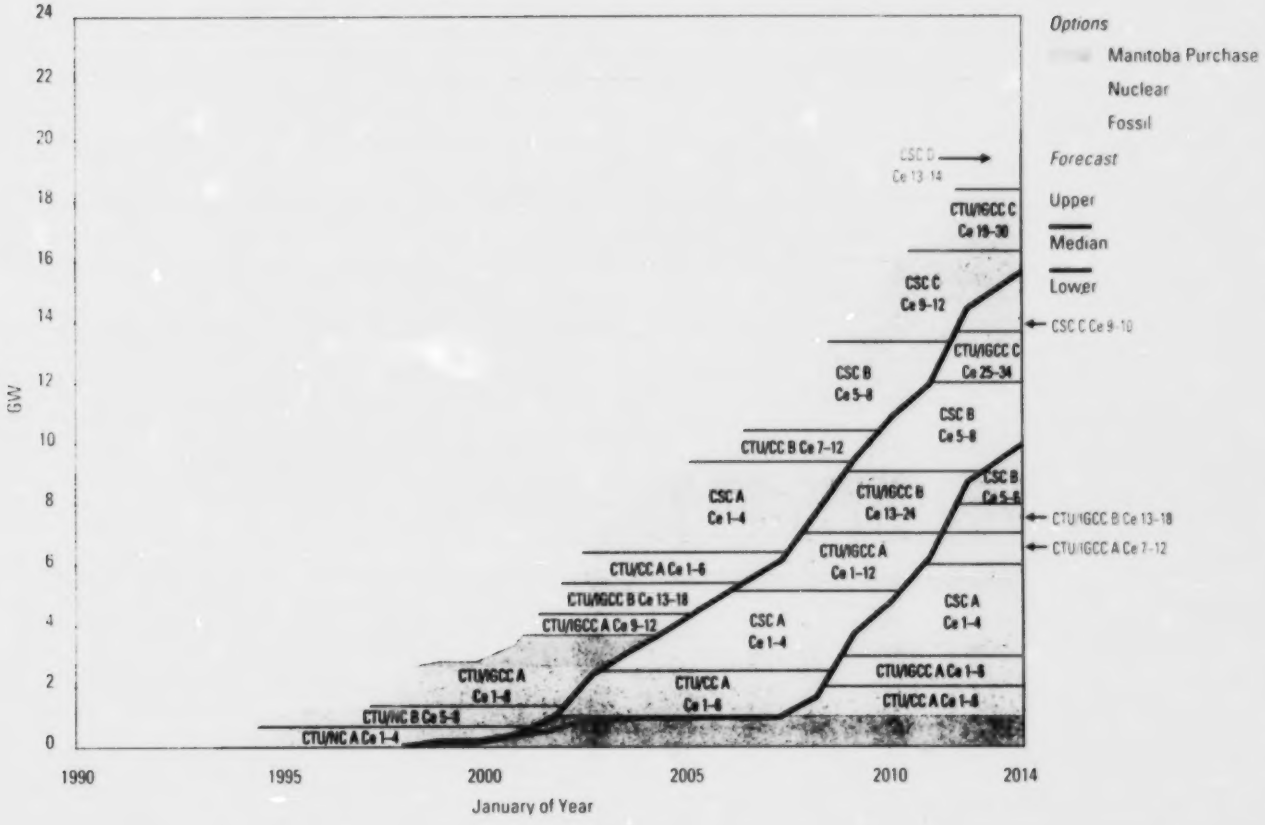


Figure 2-3 **New Major Supply** Case 26



CSC A, and CANDU B. Existing and new fossil generation meet intermediate and peak requirements. This Case requires, by 2014, four CSC Coal units at one station, six CANDU units at two stations, six CTU/CCs at one station, and 30 CTU/IGCCs at three stations by 2014.

Under the upper load forecast, the base load requirements are met, in turn, by CANDU A, CSC A, CANDU B, and two units in CANDU C. Peaking requirements, by 2014, are met by eight CTU/NCs at two stations, ten CTU/CCs at two stations and 24 CTU/IGCCs at three stations.

Under the lower load forecast, base load requirements are met by CANDU A followed by two units in CSC A. Peaking requirements, by 2014, are met by six CTU/CCs at one station and 14 CTU/IGCCs at two stations.

An alternative variation of Case 24 was analyzed. It featured a CSC coal station as the first base load station. The variant with a CANDU station first is favoured because it maintains CANDU capability in Canada.

Table 2–4 summarizes capacity additions by the end of 2014.

The approximate timing of capacity additions over the planning period is shown in Figure 2–5.

Case 22

This Case has a mix of options that fall between the mixes in Case 15 and Case 23.

Under the median load forecast, nuclear units are scheduled to reduce the need for new fossil generation until later in the period. This Case requires, by 2014, 12 CANDU units at three stations, six CTU/CCs at one station, and 16 CTU/IGCCs at two stations. Under the upper load forecast, requirements are met initially by CTU/NCs on existing sites, and then by CTU/IGCCs. Nuclear units provide

Table 2–4 Major Supply Additions by 2014
Case 24

	Capacity (GW)		
Major Supply Option	Lower Forecast	Median Forecast	Upper Forecast
Utility Purchase	1.0	1.0	1.0
CSC – Coal	1.5	3.0	3.0
CANDU	3.5	5.3	8.8
CTU/NC	0	0	1.3
CTU/CC	1.0	1.0	1.7
CTU/IGCC	2.4	5.0	4.0
Total	9.4	15.3	19.8

Table 2–5 Major Supply Additions by 2014
Case 22

	Capacity (GW)		
Major Supply Option	Lower Forecast	Median Forecast	Upper Forecast
Utility Purchase	1.0	1.0	1.0
CANDU	7.0	10.6	13.2
CTU/NC	0	0	1.3
CTU/CC	0	1.0	1.7
CTU/IGCC	1.7	2.7	2.7
Total	9.7	15.3	19.9

Figure 2–4 **New Major Supply** Case 23

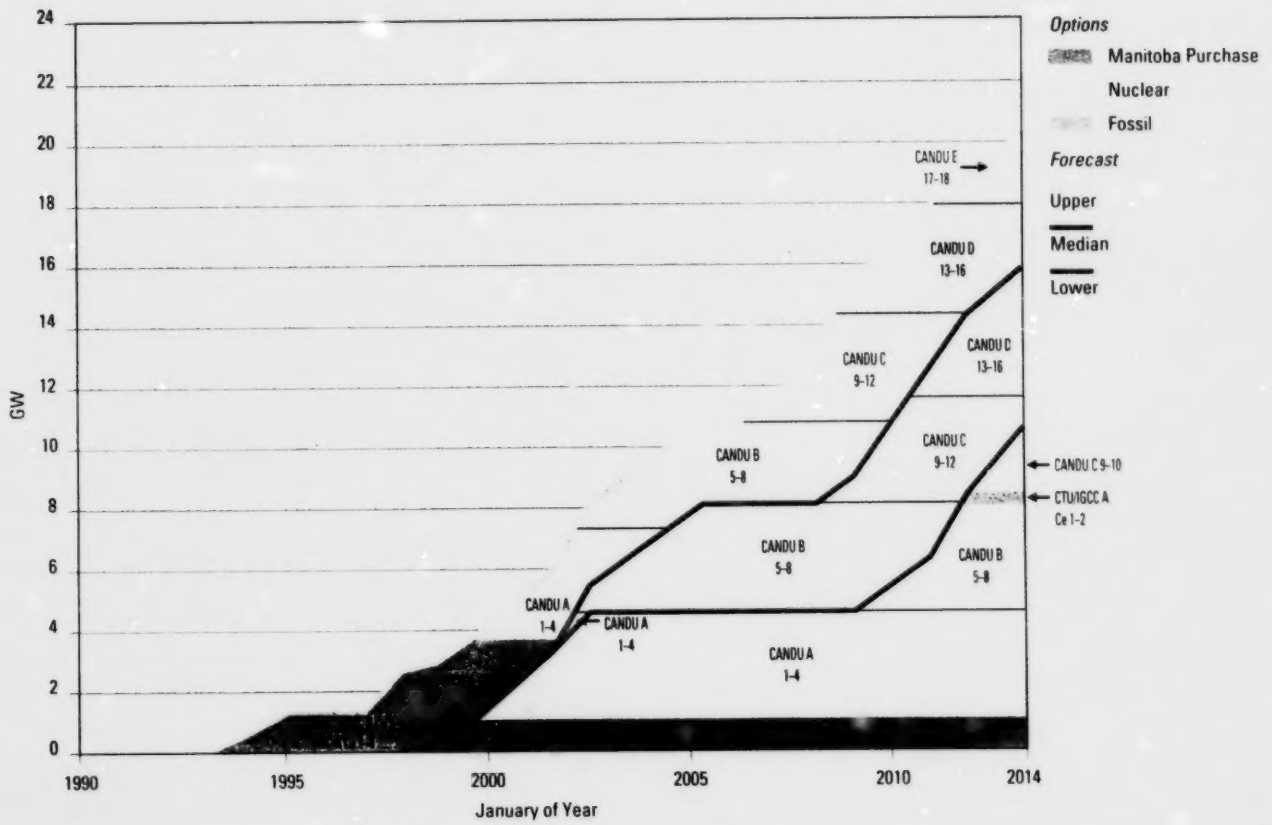
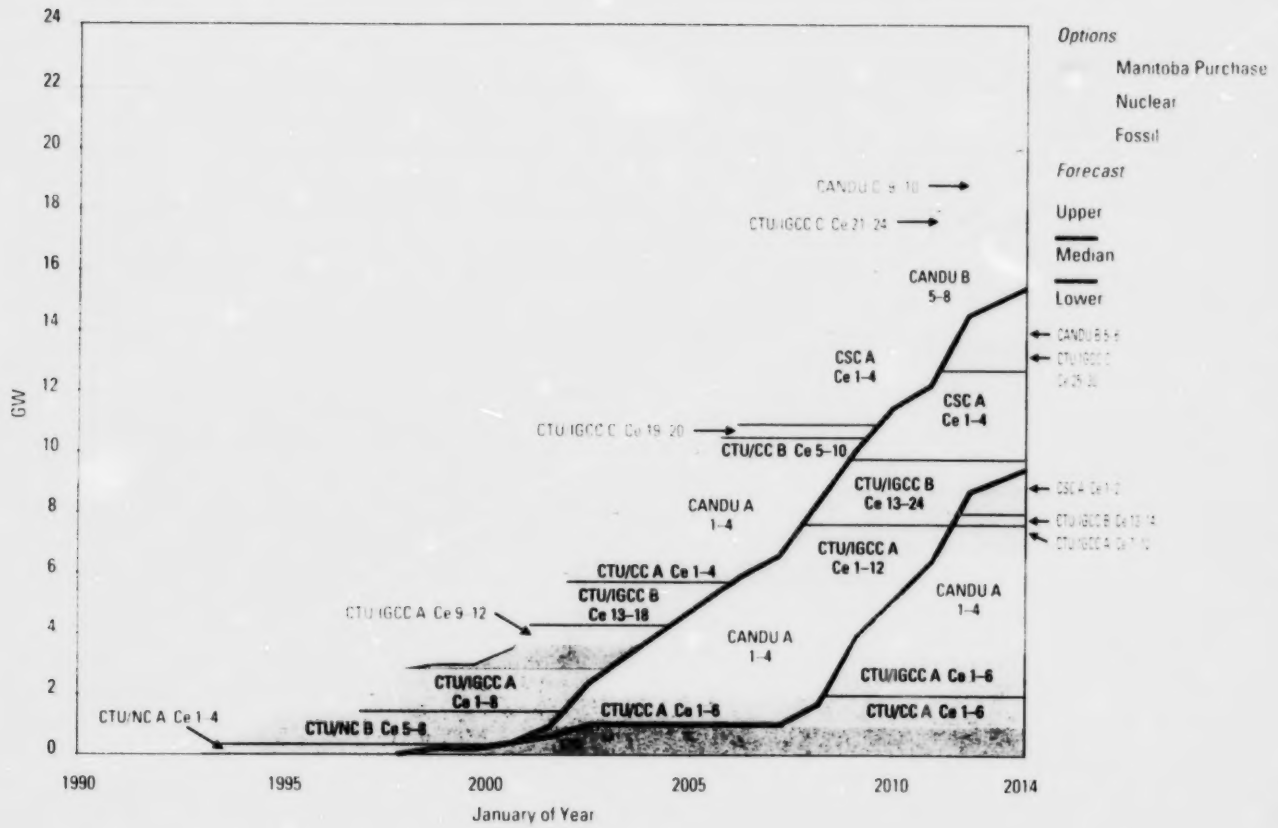


Figure 2-5 **New Major Supply** Case 24



base load generation as lead time permits. This Case requires, by 2014, 15 CANDU units at four stations, eight CTU/NCs at two stations, ten CTU/CCs at two stations, and 16 CTU/IGCCs at two stations.

For lower load forecast, eight CANDU units at two stations and ten CTU/IGCCs at one station are required by 2014.

Table 2–5 summarizes total capacity additions by 2014.

The approximate timing of capacity additions over the planning period is shown in Figure 2–6.

2.3 Candidate Sites

Candidate sites are known sites that are being considered for future fossil and nuclear generating facilities in the major supply Cases. Candidate sites are used to illustrate that it is technically and economically feasible to locate the selected options within the province. Site locations are shown in Figure 2–7, as are the locations of proposed hydraulic developments. Subsequent environmental assessments will assure that projects are located in an environmentally acceptable manner, and with opportunities for community input.

Candidate Sites for Nuclear Option

The following sites can accommodate a 4 x 881 MW CANDU station:

- Darlington (near Bowmanville)
- Wesleyville (near Port Hope)
- Bruce (between Kincardine and Port Elgin)
- North Channel Area (between Bruce Mines and Espanola)

Candidate Sites for CSC and IGCC Options

The following sites can accommodate at least one CSC or IGCC station:

- Lennox (near Bath)
- North Channel Area (between Bruce Mines and Espanola)
- Wesleyville (near Port Hope)

Existing fossil generating station sites (Keith, Lakeview, and Lambton) could be used for new stations after the existing stations are decommissioned. Some sites, such as Hearn and Keith, cannot accommodate IGCC or larger stations. These sites, however, are suitable for the addition of combustion turbine units, which can be converted to combined cycle generation. If redeveloped, Keith could possibly accommodate a small IGCC station.

Candidate Sites for CTU and CC Options

To meet the upper load forecast, Hydro requires options with very short construction lead times (2 to 5 years), such as combustion turbine units on operating station sites. Existing operating stations – Lakeview, Lambton, Lennox A and Nanticoke – are possible sites.

Hearn and Keith are currently mothballed and do not have trained maintenance and operating staff on site. In short lead-time situations, CTUs could be installed at these sites. However, these two stations are better suited for the longer lead time combined cycle stations.

This better site utilization may be precluded by the installation of non-convertible CTUs.

The following sites are potentially suitable for CTUs:

- Hearn (Toronto) – CTU/CC (Phase 1)
- Keith (Windsor) – CTU/IGCC (Phase 1)
- Lambton (Sarnia) – CTUs
- Nanticoke (Port Dover) – CTUs
- Lennox GSA (Bath) – CTUs
- Lakeview (Mississauga) – CTUs

Site Categories and Associated Sites

The location of any new sites is not specified at this time in any of the alternate plans. Site selection studies will be required to identify and select any new sites. The set of illustrative sites for each case represents a feasible choice and meets the system requirement for a geographic balance between electricity demand and supply.

In general, the Cases require sites for CANDU stations, CSC coal stations, CTUs convertible into IGCCs, CTUs convertible to CC units, and CTU/NGs without further development options.

Table 2–6 shows how illustrative sites could be used in each Case under all three load forecasts. An alternative siting sequence was also studied.

The number of sites required varies between Cases and between load forecasts (Table 5 – 3). For the upper load forecast, eight to eleven sites would be used; for the median forecast, four to seven; for the lower forecast, three to five.

To meet base load requirements, all Cases require new sites to be identified in locations that maintain geographical balance between demand and generation. For the median forecast, two sites need to be identified in Cases 15, 22, 24 and 26; and three in Case 23.

2.4 Transmission Requirements

Since the siting of generating stations has an impact on the transmission system, transmission considerations are included in this analysis. The transmission required to incorporate a new Ontario Hydro generating station will include radial transmission necessary to connect the site to the existing and planned Bulk Electricity System (BES). It may also include inter-area transmission necessary to maintain an integrated BES.

Illustrative siting and timing of options

		Case 23		Case 22		Case 15		Case 24		Case 26	
	Load	Highest Nuclear		Higher Nuclear		Balanced		Higher fossil		Highest fossil	
	Forecast		In-		In-		In-		In-		In-
Site	Condition	Option	Service	Option	Service	Option	Service	Option	Service	Option	Service
Darlington B	Lower	Candu A	1999	Candu A	2007	Candu A	2009	Candu A	2009		
	Median	Candu A	1999	Candu A	2001	Candu A	2003	Candu A	2003		
	Upper	Candu A	1999	Candu A	2001	Candu A	2002	Candu A	2002		
Hearn	Lower					CTU/CC A	2008	CTU/CC A	2008	CTU/CC A	2008
	Median			CTU/CC A	2008	CTU/CC A	2001	CTU/CC A	2001	CTU/CC A	2001
	Upper			CTU/CC B	2003	CTU/CC B	2002	CTU/CC B	2003	CTU/CC B	2003
Keith	Lower										
	Median										
	Upper			CTU/CC A	2002	CTU/CC A	2001	CTU/CC A	2002	CTU/CC A	2002
Lakeview	Lower	CTU/IGCC A	2012	CTU/IGCC A	2012	CTU/IGCC B	2012	CTU/IGCC B	2012	CTU/IGCC B	2012
	Median			CTU/IGCC B	2012	CTU/IGCC B	2009	CTU/IGCC B	2008	CTU/IGCC B	2008
	Upper			CTU/IGCC B	2012	CTU/IGCC B	2012	CTU/IGCC C	2006	CTU/IGCC C	2007
Lambton	Lower										
	Median					CTU/IGCC C	2012	CTU/IGCC C	2010	CTU/IGCC C	2010
	Upper	CTU/NC A	1993	CTU/NC A	1993	CTU/NC A	1993	CTU/NC A	1993	CTU/NC A	1993
Lennox A	Lower										
	Median										
	Upper					CTU/NC C	2001				
Lennox B	Lower										
	Median										
	Upper							CTU/IGCC B	2001	CTU/IGCC B	2001
Nanticoke	Lower										
	Median										
	Upper	CTU/NC B	1994	CTU/NC B	1994	CTU/NC B	1994	CTU/NC B	1994	CTU/NC B	1994
New Site 1	Lower	CANDU C	2012								
	Median	CANDU C	2009	CANDU C	2010	CANDU C	2012	CANDU B	2012	CSC COAL C	2012
	Upper	CANDU C	2007	CANDU C	2008	CANDU C	2008	CANDU B	2008	CSC COAL C	2008
New Site 2	Lower										
	Median	CANDU D	2010								
	Upper	CANDU D	2008	CANDU D	2011	CANDU D	2012	CANDU C	2012	CSC COAL D	2012

Illustrative siting and timing of options

Site	Load Forecast Condition	Case 23 Highest Nuclear Option	Case 23 Highest Nuclear In-Service	Case 22 Higher Nuclear Option	Case 22 Higher Nuclear In-Service	Case 15 Balanced Option	Case 15 Balanced In-Service	Case 24 Higher fossil Option	Case 24 Higher fossil In-Service	Case 26 Highest fossil Option	Case 26 Highest fossil In-Service
New Site 3	Lower										
	Median										
	Upper	CANDU E	2012								
North Channel	Lower	CANDU B	2010	CANDU B	2010	CANDU B	2012	CSC COAL A	2012	CSC COAL B	2012
	Median	CANDU B	2002	CANDU B	2006	CANDU B	2009	CSC COAL A	2009	CSC COAL B	2009
	Upper	CANDU B	2002	CANDU B	2005	CANDU B	2007	CSC COAL A	2007	CSC COAL B	2007
Wesleyville A	Lower					CTU/IGCC A	2009	CTU/IGCC A	2009	CTU/IGCC A	2009
	Median			CTU/IGCC A	2009	CTU/IGCC A	2002	CTU/IGCC A	2002	CTU/IGCC A	2002
	Upper	CTU/IGCC A	1997	CTU/IGCC A	1997	CTU/IGCC A	1997	CTU/IGCC A	1997	CTU/IGCC A	1997
Wesleyville B	Lower									CSC COAL A	2009
	Median									CSC COAL A	2003
	Upper									CSC COAL A	2002

Figure 2–6 **New Major Supply** Case 22

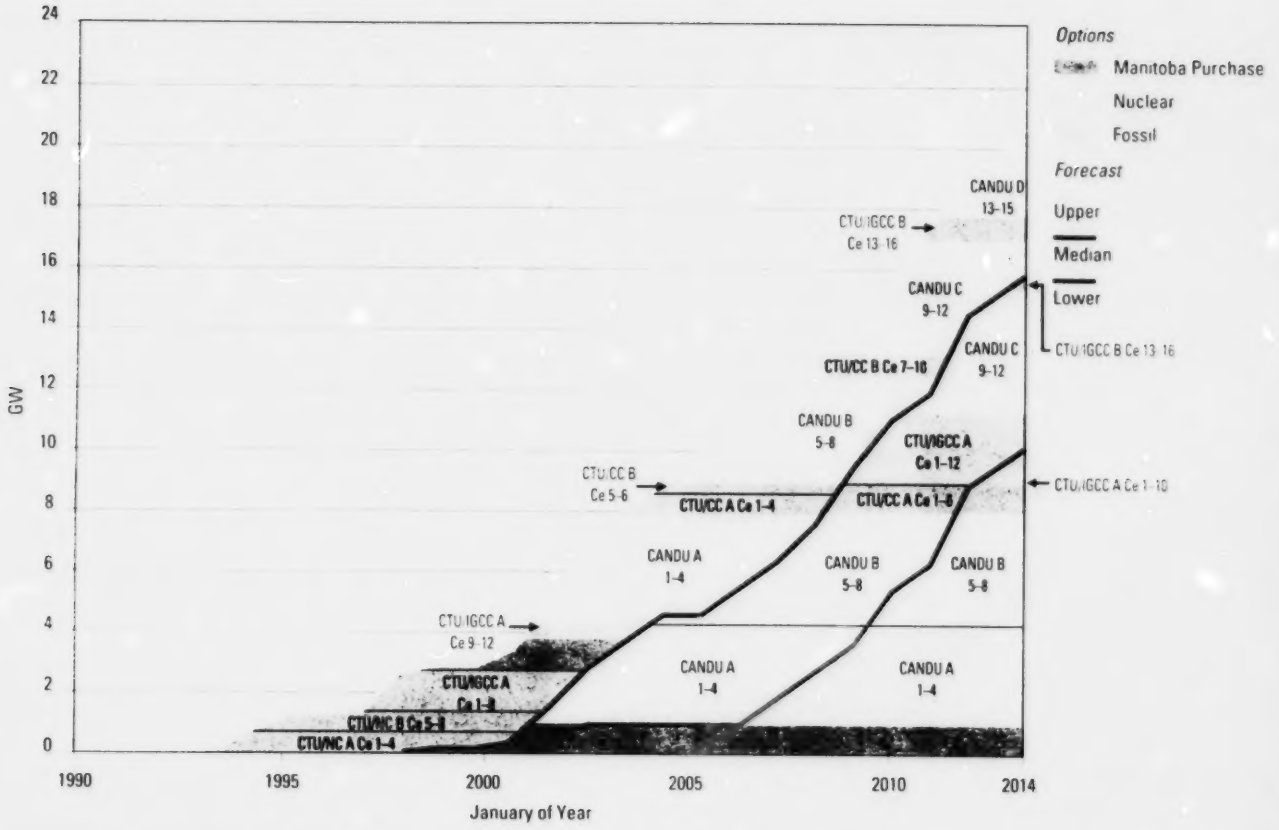


Table 2 – 7 **Major Radial Transmission Requirements for Incorporation of Major Supply**

1. Darlington B Incorporation

Bowmanville SS x Cherrywood TS

- build a 3rd 2 – cct 500 kV line, approximately 46 km, on an existing approved right-of-way

2. North Channel Site Incorporation

North Channel GS x Mississagi TS

- build two 1 – cct 500 kV lines, approximately 50 km, on a new right-of-way

North Channel GS x Sudbury Area

- build two new 1 – cct 500 kV lines, approximately 225 km, on a new right-of-way

3.Southwestern Ontario Site Incorporation

New GS x Existing 500 kV Transformer Station in SWO

- build two 2 – cct 500 kV lines, up to 100 km long, on a new right-of-way

4. Manitoba Purchase

Manitoba Border x Sault Ste. Marie area

- build one 1 – cct 500 kV line, approximately 1,100 km, on a new right-of-way

Note:This covers only the facilities required in Ontario. New 500 kV stations will be established at Dryden, Lakehead and midway between Lakehead and Mississagi stations. The proposed facilities will displace indefinitely the following planned transmission projects in Northern Ontario:

- Birch x Marmion Lake
- Marmion Lake x Dryden
- Northern Ontario Interconnection Stages I and II

Figure 2–7 **Candidate Sites Used in Alternate Plans**

The need for radial transmission is driven solely by the choice of site and its proximity to a suitable existing or planned transmission stations in the integrated system. The need for inter-area transmission can be driven by the choice of site, but is also influenced by many other factors such as security and reliability of load supply, geographic mismatch of load and generation, and operational flexib and economics.

To illustrate the differences between radial and inter-area transmission, examples of the facilities required to incorporate a generating station at a new site are given below:

North Channel Area (4 x 881 MW CANDU)

- The radial transmission required is two 500 kV single circuit lines (50 km) from the new site to the existing Mississagi Transformer Station (near Sault Ste. Marie) on a new right-of-way and, two 500 kV single circuit lines (225 km) from the new site to the existing Hanmer Transformer Station at Sudbury on a new right-of-way.
- To accommodate the increased power flows on the existing bulk transmission system, due to the new station and the Manitoba Purchase, new hydraulic developments and the purchase of non-utility generation in northern Ontario, Hydro would require a new 500 kV single circuit line (210 km) from Sault Ste. Marie to Sudbury on existing right-of-way and two new 500 kV single circuit lines (400 km) from Sudbury to Toronto on a new right-of-way.

The transmission approvals requested in this application are for the requirements and rationale for radial transmission. Specific routes for this radial transmission will be assessed as part of the project specific environmental assessment for each generation development.

As a result, this environmental analysis only addresses the radial transmission requirements for supply options at the assumed reference sites given in Section 2.3 and the transmission requirements for the Manitoba Purchase. Inter-area transmission will be dealt with in a separate planning and approval process.

The four options that require significant radial transmission are:

- Darlington B (46 km)
- North Channel Site (550 km)
- Southwestern Ontario Site (200 km)
- Manitoba Purchase (1,100 km)

The requirements are described in Table 2-7 . The distances given above in brackets are the approximate lengths of new transmission line involved. As indicated in Table 2-7, it is proposed that some of these lines be located on multi-line rights-of-way. The locations of the new rights-of-way have not been identified at this time. Route selection studies are required to identify and select specific routes.

The remaining sites require relatively short lengths of new radial transmission line on existing rights-of-way (i.e. generally less than 2 km), or no new radial transmission at all.

The amount of radial transmission required varies little among Cases. The main difference for the same load forecast is in the order and timing of additions to the Bulk Transmission System. In some Cases, particularly with lower load growth, there are differences of up to 350 km in the total length of transmission requirements. The amount of transmission required increases with load.

3.0 DESCRIPTION OF ENVIRONMENTAL ANALYSIS PROCESS

To compare alternative demand/supply plans, Hydro examined both natural and social characteristics of the "environment." Social considerations include socio-economic effects and broad social considerations (e.g., equity issues).

3.1 General Assumptions

- The evaluation focuses on environmental changes associated with the median load forecast. Low load forecast and upper load forecast are examined as sensitivity conditions in Section 5.3.
- Plan comparisons are based on an evaluation of environmental effects associated with demand management as well as all energy supply options over the study period, 1989–2014. Transmission considerations are limited to the radial transmission required to incorporate major new generation.
- Full fuel cycle effects are considered. Some effects (eg., from coal mining) will occur outside Ontario. Where possible, these will be noted, but they are not dealt with in detail in this evaluation. Other impacts during the fuel cycle (e.g., from uranium mining) could occur within Ontario but are not directly within the control of Ontario Hydro. It is assumed that where activities occur outside Ontario, or are beyond Hydro's direct control, they will be regulated to meet the appropriate environmental standards and legislation.
- Only effects associated with normal, routine operation are assessed. Provision to handle emergency or accident conditions will be made in the detailed design for each plant/facility and appropriate contingency planning will be developed.
- All new generation and transmission projects will require review and approval under the Ontario Environmental Assessment Act. Siting and routing considerations as well as site-specific effects and mitigation will be addressed in individual project environmental assessments.

More specific assumptions pertaining to the natural and social environmental analyses are detailed in Appendix A.

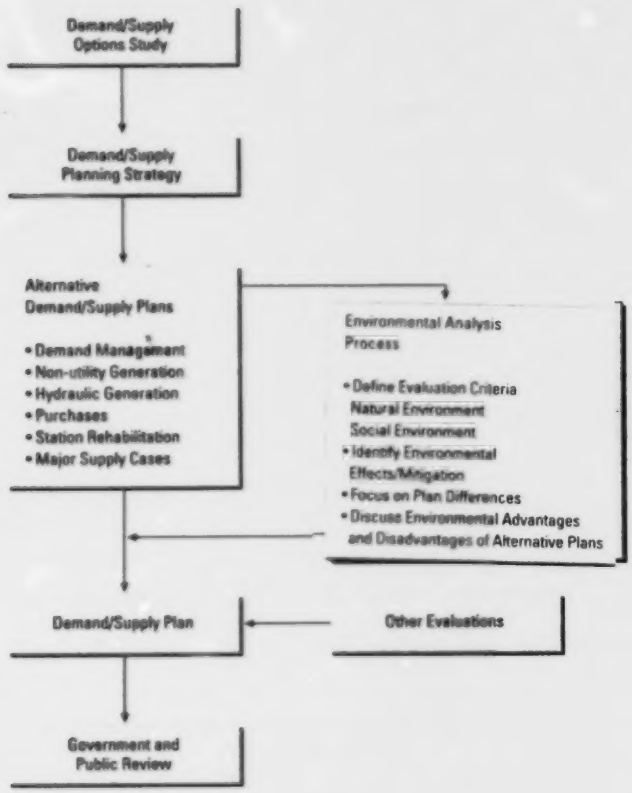
3.2 Evaluation Method

The evaluation of environmental effects was influenced by:

- the approaches used to prepare the environmental analyses of the representative plans of the Demand/Supply Planning Strategy (Ontario Hydro, 1989);
- review of approaches used in similar planning studies (BC Hydro,1989; Michigan Dept. Commerce,1987; Northwest Power Planning Council, 1989); and
- experience with the environmental assessment planning process.

Siting of generation and transmission facilities is subject to environmental assessment. Although there are differences between a general demand/supply plan and an assessment for a specific project, many of the same principles apply.

Figure 3–1 **Demand/Supply Plans**



The evaluation process includes the following steps:

- Develop a set of natural and social environmental criteria for both the generation and transmission components of the plans. Test the criteria for appropriateness, successful use elsewhere, measurability, etc.
- Evaluate the environmental implications of the alternative plans, using the criteria.
- Consider mitigation/compensation to offset the potential environmental effects of the plans.
- Determine the environmental advantages and disadvantages of the alternative plans, and identify residual effects;
- Identify and comment on constraints and concerns (ie., sensitivity considerations) outside Ontario Hydro's control, such as regulations, which might change these results.
- Document the findings and the evaluation process.

Figure 3–1 shows environmental analysis process in relation to the overall planning process.

3.3 Evaluation Criteria and Background

Evaluation criteria were developed consistent with the environment goal of the Corporate Strategy. It states that "... Ontario Hydro will develop and manage its activities and facilities in such a way as to sustain the environmental base". Furthermore, the environmental directive in the 1989 President's Initiatives states that environmental concerns and their solutions will be integrated into Hydro's planning and decision-making processes. These environmental concerns will consider preventive measures, not just mitigative measures. The general strategic principles in the Demand/Supply Planning Strategy also state, "Ontario Hydro will take a leadership role in protecting the environment and will encour-

age the social benefits associated with its activities."

Evaluation criteria were selected that are consistent with the concept of sustainable development - that is, that the needs of present generations (for electricity or any other materials) must be met without compromising the ability of future generations to meet their own needs. This concept was first introduced by the United Nations - sponsored Brundtland Commission on Environment and Development (UNEP,1987). It recognizes that economic growth is necessary, but stresses that it must be undertaken in harmony with sound environmental objectives.

The Brundtland Commission recommends that the following key elements must be reconciled to achieve sustainability in the energy sector:

- Sufficient growth of energy supplies to meet human needs;
- Energy efficiency and conservation measures, such that waste of primary resources is minimized;
- Public health, recognizing the risks to safety inherent in energy sources; and
- Protection of the biosphere and prevention of more localized forms of pollution.

The Brundtland Commission draws the following general conclusions:

- All energy sources have environmental consequences, some of which are not dealt with adequately.
- Choosing an energy strategy inevitably means choosing an environmental strategy,
- Less energy means fewer environmental problems; low energy futures are therefore more beneficial than high energy futures.

Since all of these environmental objectives are not complementary, tradeoffs must be made.

3.3.1 Natural Environmental Criteria

The selection of the natural environment criteria was based, in part, on the:

- natural environment evaluation of the representative plans used in developing the Demand/Supply Planning Strategy undertaken in 1986 (Ontario Hydro 1986a);
- experience in identifying and assessing the environmental impacts of site-specific generation and transmission facilities; and
- knowledge of environmental assessment.

The selection of criteria was also tempered by the need to develop, where possible, quantitative measures of environmental effects for comparison purposes. Since site-specific information was not available, estimates were based on current construction and operation practices, and emissions and other environmental effects for typical generation and transmission facilities. Detailed assessment of site-specific environmental effects will be carried out for individual projects.

The natural environmental criteria were selected and grouped into two broad categories to respond to sustainable development principles relating to resource use and the production of emissions, effluents and wastes.

Six natural environmental criteria were selected for this analysis of the plans. They are stated as follows:

1. Resource Use

- ***Non-Renewable Resources***

This criterion will consider the extent to which renewable and non-renewable resources are used in the alternative plans. The use of plentiful, renewable and indigenous resources is preferred and is consistent with the concept of sustainable development, while use of non-renewable resources is not. The use of non-renewable resources, such as fuels (eg., coal, oil, natural gas and uranium) and limestone required for FGD to scrub SO_2 from coal plant flue gases, will be considered. The use of fuel will be directly determined by the amount of resource required to produce a unit of electrical energy. Resource per TWh requirements vary significantly among fuels, with uranium requiring the least resource commitment per unit of energy produced.

- ***Land Use***

Estimates will be made of the total land area requirements for coal and uranium mining, new generation sites, including transmission lines, as well as land requirement for waste storage/disposal and flooding for reservoirs. Opportunities to reduce future land area requirements and/or offset potential losses will be considered.

This criterion will also consider the extent to which existing facilities are rehabilitated (ie., to make the most of existing facilities); river basin development is undertaken for future hydraulic stations; and existing rights-of-way are used for transmission facilities. These measures serve to optimize use of existing facilities and thereby reduce long-term land use.

• ***Water Use***

Estimates will be made and compared for the amount of water required for fuel mining and processing, and for cooling water use, including evaporative losses. Cooling water flow rates are assumed to reflect the potential for entrainment/impingement of fish and other aquatic organisms. Evaporative losses, although typically low (ie., less than one percent of cooling water flows), provide a measure of consumptive water use. Consumptive water use in the Great Lakes is becoming an issue.

2. Emissions/Effluents/Wastes

• ***Atmospheric Emissions***

Typical levels of sulphur dioxide (SO_2), nitrogen oxide (NOx as NO_2), total acid gas (SO_2 + NOx), carbon dioxide (CO_2), trace elements, particulates and radionuclide emissions will be estimated and compared for all plans.

Ontario Hydro's total acid gas emissions are regulated on a system-wide basis. These limits cannot be exceeded, regardless of the demand for electricity or the mix of generation options available. Acid gas limits step downward over the study period, reaching their lowest level in 1994 at 215 gigagrams annually (Gg/a) (for total acid gas) and 175 Gg/a (for SO_2). No specific limit presently exists for NOx emissions, although a recent international NOx Protocol, calling for a freeze of NOx emissions to 1987 levels by 1994, has been endorsed by the Canadian government. Ontario Hydro's NOx emissions in 1987 were 62 Gg.

CO_2 emissions are not currently regulated. Due to the growing concern over the greenhouse effect and associated global warming, there have been recent initiatives aimed at reducing CO_2 emissions. A number of regulatory groups have proposed a 20% reduction in CO_2 emissions by 2005, using 1988 as the base year. A federal-provincial task group is looking at the implications of achieving a 20% reduction target. The ability of alternative plans to meet this illustrative target will be addressed in this analysis.

Trace element emissions are small in comparison to SO_2, NOx and CO_2 emissions. These emissions are currently regulated at the local air quality level. Trace elements considered in this evaluation are listed in Appendix A.

Radionuclide emissions limits are regulated on a site-specific basis and must not exceed Derived Emission Limits (DELs) set by the Atomic Energy Control Board. Hydro routinely limits these emissions to 1% of the DEL on an average annual basis. Radionuclides considered in this analysis include tritium, noble gases, iodine 131 (I_{131}), and radioactive particulates. Total radionuclide emissions will be estimated for the plan period. Estimates of DELs will also be used to assess the ability of each plan to meet regulatory limits on an annual basis.

Noise emissions will also be considered, but no quantitative estimates will be provided, since levels are highly site dependent.

Total emissions and margins below existing and proposed regulations will be assessed and compared.

• ***Aquatic Effluents***

Estimates will be made of aquatic effluents (i.e., thermal, trace elements, radionuclide) from mining activities and generating stations and associated facilities (e.g., waste management).

Water effluents are currently regulated to meet prescribed water quality objectives. Radionuclide effluents are regulated by the AECB. Radionuclide effluents measured include tritium and gross beta.

Recent provincial initiatives under the Municipal/Industrial Strategy for Abatement (MISA) are stressing "virtual elimination" of toxic discharges to Ontario waterbodies. Discharge limits under MISA are being prepared for specific application to Ontario Hydro. Complementary to this provincial program is an evolving federal policy aimed at attaining "zero discharge" for future industrial users in the Great Lakes basin. Minimization of aquatic effluents will be an important consideration in assessing the acceptability of future generation facilities.

• ***Solid Waste Production***

Estimates will be made of the quantities of waste produced throughout the project life cycle (i.e., mining to waste disposal). These wastes include uranium and coal mining wastes, ash, FGD wastes, and radioactive wastes (ie., low level wastes and used fuel).

Reducing the waste produced in the province via active 3R programs (ie., reduce, reuse, recycle) is a fundamental part of the Ontario government's environmental initiatives. A target of a 50% reduction in solid waste production by 2000 has been recently proposed by the Ontario Ministry of the Environment (MOE). Minimization of waste production will be an important consideration in assessing future plan acceptability.

3.3.2 Social Environmental Criteria

For the purposes of this study, "community" is broadly defined to include the local or regional area potentially affected by generation and transmission projects, as well as the population of the province. Since only certain social effects can be fully assessed prior to a site selection and approval, much of the discussion is qualitative and descriptive rather than quantitative.

Detailed community impact studies will be undertaken, as part of project Environmental Assessments, to address, mitigate and compensate for social effects. Unlike many effects on the natural environment, province-wide standards do not exist to regulate social effects.

The selection of social criteria for this evaluation was influenced by:

- the 1987 social and economic evaluation of representative plans (Ontario Hydro,1987a) contained in the Demand/Supply Planning Strategy;
- project experience on environmental impact assessments and monitoring studies for generation projects;
- generic studies of socio-economic impacts of projects; and
- literature reviews and research on social impact assessment.

The social criteria are consistent with the concept of sustainable development in that an effort will be made to avoid potential effects on the social structure of adjacent communities, to comment on opportunities for mitigation and compensation and to discuss the question of the transfer of benefits/risks to future generations.

The seven social criteria selected to evaluate the alternative plans fall under two broad categories: socio-economic effects and broader societal considerations. Regional employment and development are considered to assess the balance of potential benefits and adverse effects in the area affected by the demand or supply option. The evaluation criteria are as follows:

1. Socio-Economic Effects

- ***Regional Employment***

This criterion will focus, in the context of regional labour supply and skills, on the employment opportunities afforded by construction and operation of proposed facilities.

- ***Regional Economic Development***

Opportunities to develop existing regional businesses and services will be discussed along with the potential for new businesses and services. This criteria addresses the opportunities to develop the infrastructure and economic base of a community to facilitate further economic development.

Effects on the provincial economy are dealt with in Chapter 15 of the Plan Report.

- ***Local Community Impacts***

This criterion will focus on how the size and service capacity of communities is affected by the project activities and potential population inflow. Many communities would require expansion of community or municipal facilities and services such as roads, and water and waste treatment facilities.

2. Societal Considerations

- ***Social Acceptance***

Social acceptability of the plans will depend on the extent to which Ontario Hydro has integrated changing social values into its plans. These values relate to environmental performance; the maximum achievement of publicly-preferred options such as demand management, non-utility generation, hydraulic generation, and station rehabilitation; the choice of technologies; and siting.

Social acceptance is considered from a provincial, regional and local community perspective.

Social acceptance of the Demand/Supply Plans will be addressed more fully through the Public Feedback Program, and the environmental assessment review process, both of which will provide opportunities for public input on the plans.

- ***Special/Sensitive Groups***

Certain population groups may be more affected by change than the rest of the population, because of their cultural heritage, size, socio-economic status, or special interests. These groups will be identified and potential effects will be discussed.

- ***Lifestyle Impacts***

This criterion will focus on the character of the community, the stability of the population, and lifestyle. Typically, younger, rapidly growing communities are more resilient to change than older, more established communities, or communities with a particular traditional lifestyle. Effects on the broader community of the province will also be considered.

- ***Distribution of Risks and Benefits***

This criterion will consider the distribution of benefits and risks of the alternative plans among population groups, regions, and generations. Generally, it is preferable that those who bear the risks also share equitably in the benefits.

4.0 Evaluation of Common Elements in Alternative Plans

This section will focus on the potential environmental effects of the components common to all the alternative plans. Since little site-specific information is available for many of these components, much of the discussion is generic in nature.

The following components are common to all the alternative plans:

- demand management
- non-utility generation
- hydraulic generation
- station rehabilitation
- Manitoba purchase

A summary of environmental effects and mitigation associated with each of the common elements is presented in Appendix C.

4.1 Demand Management

4.1.1 Natural Environment

Resource Use

Generally, demand management options (ie., energy efficiency improvements and load shifting) have favourable environmental effects. The focus of these programs is on using energy more efficiently (e.g., commercial lighting improvements), thereby achieving more energy services for the same environmental effects of operation. In addition, successful demand management programs may defer the need for additional new supply. However, the environmental benefits achieved through deferral of the need for new supply may be limited, if this deferral contributes to continued use of less efficient supply resources over the long term. Periodic replacement of older, less efficient generating stations with newer, more efficient plants has both system efficiency and environmental benefits, given that newer plants will have more comprehensive environmental controls and more energy efficient systems.

The success of demand management programs in shifting load to off-peak times may also produce environmental benefits by flattening the daily demand peak and hence allowing the operation of more efficient and cleaner energy sources.

Environmental characteristics of demand management options have not been scrutinized as extensively as supply options. Most of their potential environmental effects relate to the manufacture of demand management equipment and to the disposal of inefficient equipment. Preliminary estimates of these effects indicate that they are negligible when compared to the effects of producing the displaced power through conventional generation (Michigan Dept. of Commerce, 1987; NPPC, 1989).

Measures to improve building or equipment efficiency could lead to increased use of quantities of certain non-renewable resources (eg., insulation, copper).

Emission/Effluents/Wastes

Insulation of homes and commercial buildings

can reduce opportunities for infiltration of fresh air. This may adversely affect indoor air quality by increasing concentrations of NOx, radon, formaldehyde, volatile organics, and carbon monoxide. This potential air quality concern can, however, be offset by restricting use of potentially harmful substances (mainly in new buildings or in renovations) and by upgrading ventilation systems (e.g., air exchangers) in parallel with new insulation programs. Programs to encourage weatherization promote the use of these systems.

Phasing out and disposal of less efficient appliances and equipment is an important part of demand management. However, disposal of less efficient appliances, like refrigerators, can create not only a significant waste disposal problem, but also a potential chlorofluorocarbon (CFC) problem due to the escape of CFCs from compressors and polyurethane insulation in refrigerators. Some programs will require the management of environmentally sensitive materials. For example, a program to replace fluorescent ballasts requires the safe disposal of old PCB-contaminated ballasts. Although phased out equipment may not pose a contaminant problem, it is not easily recycled, and therefore contributes to increases in waste quantities.

4.1.2 Social Environment

Socio-Economic Effects

Conservation-related employment will be created in communities across the province in many sectors, including trades required to install and maintain energy efficiency equipment; the material supply and manufacturing sectors; energy service specialists and the personnel required to develop and implement programs. Although total provincial employment may be higher and all communities will benefit, the employment benefits created in any one locality will not match the employment benefits of a major supply project.Because the effects of demand management programs will be distributed across the province, there is little or no opportunity for focused regional development.

Without major construction activity, demand management programs are unlikely to create significant direct local community impacts. However, up-graded energy efficiency standards and building code amendments for new residential developments and conservation incentives may affect real estate markets, regional planning and approvals, and inspection requirements. This, in turn, may affect the type, cost, and pace of residential development.

Societal Considerations

Demand management through load shifting, increased efficiency or incentives has potential impacts on individuals and households. Load shifting, through time-of-use rates, may induce major changes in the ways energy is used by customers. Residential customers, for example, may change the pattern of their household activities. Time of use, seasonal, and interruptible rates for industry may also result in changes to working hours. Increased use of night shift and weekend operations would affect employees' personal and family life.

Conservation, through the substitution of high-efficiency equipment, will have little or no impact on the lifestyles of Ontarians. The same is true of load shifting equipment such as storage water heaters.

Depending on the structure and availability of incentive or assistance programs, special interests or sensitive groups may be adversely affected. For example, low-income customers may be affected by energy cost increases, accessibility to conservation measures or variable rate structures. In addition, programs for electrically heated residences may be seen as inequitable by owners of homes with other heating equipment. Time-of-use rates may also be perceived as inequitable by those who are unable to take advantage of them. Potential inequities can be partially addressed by providing a broad range of programs with incentives structured so that all, or most, customers have an opportunity to benefit.

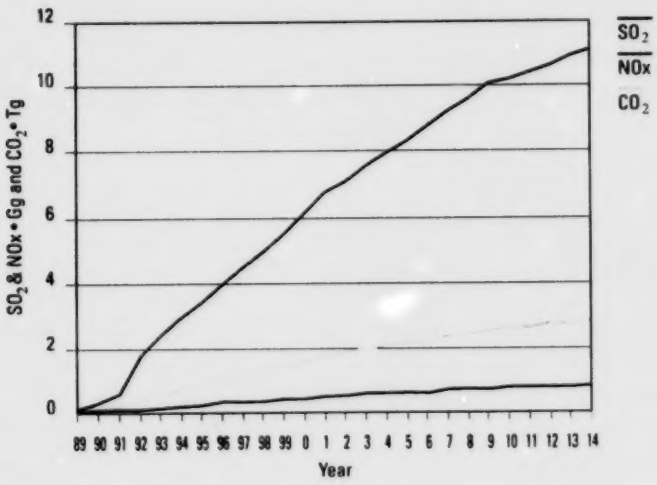
4.2 Non-Utility Generation (NUG)

General Considerations

The smaller, localized nature of NUG projects, and the fact that they will be dispersed throughout the province, suggests that many of the environmental effects associated with these projects will be less than those for larger, more centralized, conventional generation options. Figure 4–1 provides an estimate of the atmospheric emissions for NUGs assumed over the study period. Although these emissions are only a small fraction of the total emissions associated with each plan, emissions on a per TWh basis may be quite similar to larger conventional generating stations.

Since NUGs have a relatively short construction schedule, and will be dispersed throughout the province, they will produce limited regional employment and development, and will have minimal adverse community effects.

Figure 4–1 **Annual Atmospheric Emissions From NUG (1989–2014)**



Note 1. Assuming NUG mix of
18.0 % Hydraulic
74.0 % Natural Gas
4.6 % Wood Waste
3.4 % MSW/Landfill Gas
2. NUG Emissions as % of Ontario Hydro Emissions (1989–2014)
CO_2 = 6%
NO_2 = 17%
SO_2 = 0.4%

The dispersed nature of NUGs may also complicate the transmission required to incorporate these facilities into the BES. Natural and social environmental effects will vary, depending on the length of new line required and other project-specific factors.

A variety of NUG projects are likely to be undertaken in Ontario. NUGs include: gas-fired cogeneration, municipal solid waste incineration, wood waste burning, and small hydraulic generation. Following are specific natural and social environmental concerns associated with each.

4.2.1 Gas-fired Cogeneration

Most of the non-utility generation over the next 25 years is expected to be some type of gas-fired cogeneration. These gas-fired projects will produce air emissions (NOx, CO, CO_2), noise, and have some measure of consumptive water use. NOx emissions can be controlled with appropriate technologies such as steam injection. Waste disposal concerns should be minimal since gas burns efficiently. If a right-of-way does not already exist, there would be effects associated with providing gas pipeline access to a site.

Cogeneration projects can make industries more energy efficient and hence, more competitive. To the extent that this allows industries to prosper, there may be indirect employment and development benefits. However, the advantage of reduced energy costs from cogeneration may not be sufficient to offset the cost of locating in northern or remote communities.

4.2.2 Municipal Solid Waste Incineration

Municipal solid waste (MSW) facilities offer an opportunity to both reduce local landfill requirements and produce electricity. They also provide a means of reducing incremental methane emissions that could develop from decaying solid municipal wastes. Methane is an extremely potent greenhouse gas, but can also be burned to produce electricity.

However, MSW facilities have generally been strongly opposed in urban areas because of perceived health risks. The potential release of toxics (eg., dioxins) can result from the burning of plastics and other organic materials in waste. These potential emissions can be effectively controlled through the installation and use of appropriate emission control equipment. For example, Environment Canada's National Incinerator Testing and Evaluation Program found that lime and filter bag scrubbers reduced dioxins and furans to detection limits (Environment Canada, 1986).

When these toxic materials are removed from flue gas, they generally end up in the ash produced by the incinerator. Prudent landfill practices (eg., liners) will be required to ensure that leachate from any disposal site is controlled. Since MSW facilities will likely be sited close to large urban areas, environmental control requirements are expected to be stringent and expensive.

The delivery and stockpiling of MSW may cause concerns about traffic, noise, and odour in the communities surrounding the plant. Prudent processing of wastes, as well as buffering from surrounding communities, and adjacent households and businesses, will be important at MSW sites. As well, it is likely that other special considerations will be needed for nearby residents.

Some benefits may arise from increased employment and expansion of some municipal services such as roads. Regional economic development is not likely, and distribution of risks and benefits could be an important local issue.

4.2.3 Small Hydraulic Generation

Small hydraulic developments are those with capacities of less than 10 MW. These are usually developed on rivers that have existing control structures, or dams that are not currently used for power generation purposes. Many of these structures were originally installed for flood control purposes. Some were previously used for other industrial purposes (eg., grist mills). New dams may be constructed at sites on smaller waterways close to localized industry requiring electricity.

From a sustainable development and government energy policy viewpoint, encouragement of small, private hydraulic development is desirable, since it makes use of an indigenous, renewable resource. Customer and public preference for further hydraulic development is also very high.

Redevelopment of existing control structures and dam sites is expected to have few adverse environmental effects other than some short-term, localized effects on water flows and sedimentation patterns. Prudent planning of these activities to periods of low river use will reduce any potential negative impacts.

Development of a new dam on a waterway could have significant effects on resident fish populations by disrupting spawning and migratory patterns. Other existing water uses (eg., canoeing) could also be disrupted. Construction of the dam could also have some temporary, localized effects on flows and turbidity. However, careful construction planning should minimize long-term impacts. In particular, blasting must be timed to avoid biologically sensitive periods (ie., spawning seasons).

Since most small hydraulic facilities tend to be operated as run-of-the-river (non-peaking) plants, there is limited reservoir storage. Water level fluctuations are minimal, with little impact on flow patterns.

4.2.4 Wood Waste Burning Plants

Since these plants will be developed in conjunction with existing pulp and paper operations, most facilities will be sited in northern Ontario, where the bulk of forestry activity occurs. The plants can likely be accommodated on existing kiln sites.

Wood burning requires some use of cooling water, and produces atmospheric emissions (CO, CO_2, NOx, particulates), as well as ash residue, which requires disposal. Appropriate stack emission controls, especially for particulates, and prudent waste management practices, should minimize concerns. Burning wood waste reduces methane emissions that would likely occur if such wastes were stockpiled and decayed. Methane promotes greenhouse warming.

Host industries could become more competitive, if energy savings are realized through wood burning facilities. Construction of a wood waste facility in, or near, a community with high unemployment and need for development may provide a significant local economic stimulus. Social acceptance of this type of plant may be high due to its familiarity and existing role in the regional economy.

4.3 Hydraulic Generation

4.3.1 Natural Environment

Hydraulic generation is a renewable, indigenous resource and, as such, is preferred from a sustainable development perspective. There are an estimated 18 undeveloped hydraulic sites in the province which are considered to be cost-effective for Hydro to develop (see Appendix B). Except for the Little Jackfish project in northwestern Ontario and expansion of the Sir Adam Beck facility on the Niagara River, the majority of these sites (i.e, 12) are within the Moose River drainage region or involve redevelopments of existing sites. The Action Plans include 11 of these undeveloped or underdeveloped sites (see Chapter 18, Plan Report). Details of the Hydraulic Plan are discussed in Chapter 12 of the Plan Report.

Ontario Hydro's proposal to use a river system approach to develop these sites has a number of environmental advantages. First, an orderly and sequential development of sites on one river system will ensure that the development of the hydraulic sites is compatible with the other resource uses, mainly recreation, within the river basin. Second, in contrast to new development in a pristine watershed, the river system approach will tend to minimize the environmental damage, by taking advantage of existing infrastructure such as roads, rights-of-way, and construction camps. Ontario Hydro is pursuing approvals for a 30-year development plan for the remaining potential in the Moose River Basin. Discussions have been initiated with interested government and public representatives.

Hydraulic developments, however, are not without environmental effects. The major environmental change relates to reservoir creation and the related problems of land/habitat displacement, loss of riverine fish habitat, increased mercury levels in the reservoir, and erosion/siltation problems. Redevelopments, where there is little or no incremental flooding required, will generally have less environmental impact than new developments. Incremental flooding associated with the 18 sites included in the current alternative plans is estimated at about 8973 ha, and is summarized on a site-specific basis in Appendix B.

Concerns at Little Jackfish relate mainly to water quality issues (ie., erosion control and elevated mercury levels in fish). Potential environmental concerns associated with the Niagara River development include possible water quality changes due to in-stream construction of the intake and powerhouse structures, alteration of fish migration patterns and habitat, and potential disturbance of environmentally sensitive areas or rare wildlife and plants. Issues in the Moose River Basin relate to potential effects on fisheries; effects associated with providing access (eg., increased hunting pressure on local wildlife resources) and developing aggregate resources; and downstream effects in the James Bay estuary area.

There are several mitigation measures which reduce the environmental impact of reservoir development. The primary one is the development of a reservoir preparation plan which will help to reduce mercury levels and maximize opportunities for multiple use of reservoirs. Reforestation programs may also help to offset resource/habitat loss concerns associated with flooding. Site-specific effects and mitigation associated with each proposed development in the hydraulic program will be assessed in project-specific EAs.

The only sizeable remaining resource in the province, after the current 18 site programs, is about 3800 MW of capacity in the Hudson Bay Lowlands (ie., Albany, Severn, Attawapiscat and Winisk). At this time, development of these hydraulic resources is costly, requires substantial flooding, and is likely to encounter serious opposition from Native and naturalist interests. (Ontario Hydro, 1982).

Present government policies relating to hydraulic development could affect future development of this renewable resource. Newly-approved Provincial Parks policies (MNR, 1988) prohibit the development of hydraulic generation facilities, including flooding from reservoirs, within approved park boundaries. This provision will limit the ability of Hydro and the private sector to pursue certain hydraulic sites. For example, the proposed Waterway Park on the Missinaibi River in northeastern Ontario will preclude development of at least one site on the Moose River.

4.3.2 Social Environment

Socio-Economic Effects

Orderly development of northern hydraulic sites should provide opportunity for regional employment and development in the north. Development, redevelopment or extension of sites in the Moose River Basin could provide up to 23,500 person-years of employment over 30 years. Workers could transfer from one site to the next, and economic benefits in regional centres would continue throughout the period. However, to ensure that employment and development

opportunities are realized, a co-operative effort by Hydro, construction trade unions, and the provincial and federal governments would be necessary.

Development of individual northern hydraulic sites such as Little Jackfish may provide the opportunity for short-term construction employment. Again, realization of this benefit will require a co-operative effort by Hydro, trade unions, and governments to ensure that employment opportunities are available for local residents. There may be some short-term benefits for local retail employment, but few long-term jobs. Any resulting "boom-bust" effect would require mitigation measures.

Northern hydraulic developments may have additional regional development effects, such as electrification of remote communities and improved road access, which are prerequisites for economic development.

Communities in the vicinity of the northern projects generally lack the infrastructure and services to accommodate an influx of people, and the structure to manage a coordinated response to changing community circumstances. Even with self-contained workforce camps, some effects will be felt on surrounding communities' retail and service sectors. These will be relatively short-term for individual sites, but long-term in communities serving the Moose River Basin development. In both instances, mitigation and monitoring programs will be necessary.

A Niagara development will have limited negative impact on the community and its municipal services. Potential effects relate more to construction activity in an urban area, including traffic, noise, dust, etc., which may arise from the construction of tunnels and the disposal of excavated material as well as from the construction of the generating facility. The Niagara development construction workforce will be supplied by a local and commuting workforce. It will provide only short-term regional benefit. The development may be of concern to tourism interests if construction or operation of the facilities is disruptive.

Smaller projects, such as Lake Gibson and Big Chute, will provide short-term construction employment but will have limited regional development potential.

Societal Considerations

Development of northern hydraulic sites will arouse Native concerns such as land claims, impacts on traditional land uses, lifestyles and livelihood, and participation in the employment and economic benefits of the developments. Native people and others dependent on subsistence, commercial, or recreational fishing, will be concerned about the effects on fish populations and the potential for mercury contamination of fish in flooded areas.

Hydraulic developments in recreation areas may be of concern to cottagers, boaters, fishermen, and other users if water flow or quality are adversely affected.

Social acceptance of the Niagara development will be improved by measures taken to prevent construction and operation from affecting the aesthetics of the area.

Northern hydraulic projects could result in changes to the lifestyle of residents and to the character of communities. Traditional activities of Native people may be affected by alteration of the environment and by changes to employment patterns as a result of the projects. For example, flooding and concerns about mercury levels in fish may result in changes to traditional hunting, fishing, and dietary patterns. The character of communities servicing Moose River Basin projects is likely to change as a result of the long-term development. However, electrification of northern communities, or improved service will be of benefit to these communities.

Northern hydraulic developments have significant potential to adversely affect the community, special interests, and lifestyles. These effects may be balanced by potential employment and economic development benefits. Special initiatives will ensure that those adversely affected share in the benefits.

4.4 Station Rehabilitation

4.4.1 Natural Environment

Rehabilitation work at existing hydraulic stations is unlikely to have major environmental effects. Provided dam repair or replacement work is carefully scheduled to avoid biologically sensitive periods (e.g., fish spawning), effects are likely to be of short duration and very localized.

Providing access to some older dam-sites could be difficult. Access road routing must be undertaken in consultation with potentially affected individuals. Anticipated upgrades at the hydraulic stations themselves (e.g., runner replacements) are likely to involve measures that do not appreciably change flow patterns in the affected rivers. A Class EA process has been established to review hydraulic station modification projects. If anticipated effects are judged to be significant, a full individual EA may be necessary.

Retubing at nuclear stations, particularly in the 1990s, will require that lost power from nuclear reactors is made up by increased use of fossil stations. However, through Ontario Hydro's Acid Gas Control Program, appropriate control measures will be put in place to maintain acid gas emission levels within regulatory limits.

Fossil station rehabilitation also has some potential to affect the natural environment. Much of the rehabilitation efforts will be aimed at restoring operating efficiency of these plants, which will tend to reduce acid gas emissions and effluents over the long term. However, a number of planned measures (e.g., installation of scrubbers) have the potential to significantly increase solid waste volumes produced, and may therefore require increased landfill storage space.

To reduce long-term waste disposal requirements at these stations, efforts will be undertaken to maximize re-use and recycling opportunities. For example, with some modification of the FGD process, scrubber waste from certain technologies can be used for wallboard gypsum production. Production of synthetic FGD gypsum could also result in reduced land disturbance associated with natural gypsum mining in southern Ontario. Fly ash has been used extensively as a cement additive for mine backfill and for hazardous liquid waste stabilization purposes. Pending government regulations pertaining to the use of flyash and other combustion by-products for backfill material will affect future opportunities to use these wastes.

4.4.2 Social Environment

Rehabilitation projects may offer some opportunities for local employment where new construction is required. Where substantial engineering changes are needed, specialized, skilled labour will be required. Employment opportunities could provide an important local economic stimulus in areas where unemployment levels are currently high. Construction times associated with these activities will be substantially less than those for full station development, probably in the 3-5 year range.

The communities around most existing stations on the BES are stable and, in most instances, have become accepted parts of the community infrastructure. Rehabilitation projects will be limited mainly to within the existing site boundaries and are not expected to have any significant long-term impact on nearby established communities. There may be some localized, short-term effects (e.g., noise, dust) associated with rehabilitation construction activities. In some cases, rehabilitation projects could provide an opportunity for dealing with certain persistent problems related to station operation (e.g., dust blowing off coal piles or ash disposal areas). In many instances, rehabilitation projects are being undertaken to maintain or upgrade a station's energy producing and/or environmental performance (e.g., installing FGD). Therefore, there should be a net overall improvement in the environmental quality around the site over the long-term.

4.5 Manitoba Purchase

Long-term firm purchases of hydraulic power from neighbouring provinces, such as Manitoba, are an alternative to building new supply facilities in Ontario (Ontario Hydro, 1989a).

Any environmental effects in Ontario resulting from the Manitoba purchase would be related to transmission incorporation. The Manitoba Purchase would require up to 1,100 km of new right-of-way in Ontario, which would occupy a total area of about 9,000 ha.

Establishing a new transmission right-of-way from the Manitoba border to the Sault Ste. Marie area would displace timberland, infringe on several Forest Management Agreement areas, and may affect mineral and aggregate deposits.

Routing could affect cottaging, hunting and fishing activities, especially commercial fly-in operations. Many relatively unspoiled scenic river valleys and other natural areas will also be affected.

Other concerns include rural residential development, which exists in significant concentrations in some areas, and the issue of increased access into remote areas.

Access is an important resource management issue in northern Ontario. Increased access for transmission line construction and maintenance is seen as a benefit by some, and an unwanted intrusion by others. These impacts can be mitigated by routing transmission facilities to avoid or reduce disruption and displacement, and by implementing impact management programs such as application of site restoration guidelines.

Most of the socio-economic concerns and environmental considerations which may arise from the Manitoba purchase will occur in that province, and will be reviewed in Manitoba.

5.0 Evaluation of Differences Among Major Supply Cases

Before dealing with environmental differences among major supply Cases, it is useful to review the typical environmental effects and potential mitigation associated with the major supply options.

5.1 Typical Environmental Effects and Mitigation Associated with Major Supply Options

Environmental effects associated with transmission incorporation for these major supply Cases are also discussed briefly. Summary tables showing typical effects and mitigation for each supply option appear in Appendix C.

5.1.1 Fossil Fuel Options

5.1.1.1 Conventional Steam Cycle (CSC) Coal

There are potential natural and social environmental effects throughout the entire fuel cycle for a conventional steam cycle (CSC) coal generating station. The largest effects on the natural environment will be those associated with coal extraction (e.g., coal mining and transport); air emissions (Table 5–1) from coal combustion (e.g., SO_2, NOx, CO_2, particulates); cooling water use; and waste disposal (i.e., coal ash and scrubber by-products).

Atmospheric emissions, SO_2 and NOx, can adversely affect air and water quality, vegetation and human health, both in the vicinity and downwind of a CSC plant.

Increasingly, CO_2 emissions are being linked to global warming trends.

Cooling water use can impinge/entrain fish and other aquatic life in the adjacent aquatic environment. Waste disposal can produce nuisance fugitive dust emissions or leachate effects on nearby water sources. Other potential effects relate to increased land displacement for coal extraction, generation, transmission, and waste disposal facilities.

Many of these potential effects can be reduced or eliminated through mitigation programs. Air emission concerns can be reduced by burning low-sulphur coal (eg., Western Canadian coal) and/or installing equipment to control acid gas and particulate emissions (e.g., electrostatic precipitators, flue gas desulphurization (FGD), flue gas conditioning (FGC), or selective catalytic reduction (SCR)). Prudent handling, storage, and recycling/re-use of wastes can significantly reduce waste management concerns. Wherever possible, existing sites and rights-of-way will be used to minimize land consumption/expropriation. Extensive environmental monitoring will be carried out in the vicinity of stations to ensure that regulatory standards are met.

CSC coal generation can also produce social and community effects. The most prominent possible effects are those related, directly or indirectly, to employment, regional devel-

opment, and local community effects. Development of a large CSC facility often increases employment and spending in the local host community and surrounding region. Frequently these economic benefits offset the adverse effects of community disruption (e.g., negative effects on social networks and infrastructure). This is especially true in northern or remote communities.

Community impact monitoring programs and impact management agreements are developed in consultation with host communities to manage the potential socio-economic impacts of a large industrial facility like a coal-fired generating station. Local lifestyles may be affected if there are real or perceived effects on the natural environment. Public acceptance of CSC facilities, as identified through Ontario Hydro's public attitude research, is linked to concern about this technology's contribution to acid rain, and long-term environmental degradation associated with global warming. Special interest groups, local residents and businesses may be concerned about changes to the local economic base, health and safety risks, and distribution of costs and benefits.

5.1.1.2 Integrated Gasification Combined Cycle (IGCC)

Gasification is the burning or "cooking" of coal to produce a combustible material known as syngas. Coal-derived syngas is low in sulphur content; moreover, the sulphur can be effectively and cheaply removed. IGCC plants can use high-sulphur coal, provided the coal has low moisture content.

The process takes place in a gasifier, which is essentially an oven where temperature and pressure are used to drive syngas off the coal. Gasifiers integrated with other systems are referred to as integrated gasification combined cycle (IGCC) systems. The term "combined cycle" refers to the ability to generate electrical energy from syngas simultaneously in two ways; first, by burning the syngas to drive a combustion turbine and second, by producing steam from the hot syngas and CTU exhaust gases to drive a steam turbine.

An IGCC facility can be constructed in a "phased" or "unphased" manner. Phasing construction offers the ability to increase plant size in line with demand and spread out capital investments. There are three phases: 1) combustion turbine, burning natural gas; 2) combined cycle; 3) coal gasification, a step taken if price increases make natural gas uncompetitive. Each phase can be constructed in two to four years.

Many of the potential natural and socio-economic environmental effects associated with an IGCC station will be similar to those for a conventional steam cycle plant, but will be of a lesser magnitude. Natural environmental effects will be associated with coal extraction (e.g., coal mining and transport), air emissions from gasified coal combustion (e.g., NOx, particulates), cooling water use, and waste disposal.

Relative to conventional steam cycle technology, IGCC SO_2 and CO_2 emissions will be proportionally lower, while NOx emissions may be slightly higher (Table 5-1). NOx emissions are controlled in the gas turbine via steam/water injection and combustion control. As combustion units increase in size, they operate at higher temperatures. As a result, NOx emissions may increase. Multi-nozzle combustors with increased steam injection, or SCR, can be used to reduce NOx emissions and at the same time improve turbine reliability (EPRI,

Table 5-1 Environmental Performance of Fossil Options (g/kWh)

Option Number	Description	SO_2	NO_x	CO_2	Solid Wastes
1	4x800 MW US Coal CSC/FGD/SCR	1.6	0.25–0.31	860	95
2	4x500 MW US Coal CSC/FGD/SCR	1.6	0.25–0.31	860	95
3	4x500 MW WC Coal CSC/SCR	2.3	0.25–0.31	910	48
4	2x150 MW Oil CTU	1.6	0.88	880	0
5	2x150 MW Gas CTU	0	0.87	605	0
6	2x660 MW CC/SCR – Intermediate	0	0.25–0.31	430	0
7	2x660 MW CC – Peaking	0	0.62	425	0
8	4x660 MW Phased IGCC*	0.52	0.30–0.53	905	31
9	4x660 MW Unphased IGCC/SCR	0.47	0.25–0.31	805	28

* Data shown for CTU and CC phases are similar to Option 5 and 7 respectively.
Source: Ontario Hydro, 1989d

1988). Baseload IGCC will likely require SCR. Although the IGCC technology does not require removal of SO_2, it may require control of H_2S produced as a by-product of the gasification process.

Since a large proportion of electrical energy generated by an IGCC plant is produced using air-cooled gas turbines, cooling water requirements will be lower than those for a CSC plant.

As with a CSC facility, there will be land displacement concerns related to coal extraction, generating sites, transmission corridors, and waste disposal. Compared to a CSC using unscrubbed coal, waste disposal requirements will be similar; compared to a CSC station with FGD, IGCC waste disposal requirements will be significantly less (Table 5–1). Prudent handling, storage, and recycling/re-use of wastes can significantly reduce waste management concerns. For example, elemental sulphur removed during the gasification process can be sold to the chemical industry. The slag removed from the combustor chamber consists of a non-hazardous, inert "glassy" material, which is easy to handle and can be used for construction purposes (Ferguson, 1989).

The main socio-economic effects of an IGCC facility are related to employment and regional development. Given its phased, modular nature (i.e., station modules could be built elsewhere and transported to the construction site), peak construction workforce requirements are likely to be lower for an IGCC facility than for a comparably-sized CSC facility. However, the phased construction program for IGCC may provide employment opportunities over a longer period of time, thereby leading to additional regional economic development.

Since an IGCC facility contains elements of a chemical plant, there will likely be health, safety and odour (eg., H_2S emissions associated

with gasification) concerns. People living or working near these facilities may feel they bear more risks than others living or working further away. However, clean coal technologies, such as IGCC, produce relatively low emission levels and are hence favoured over conventional CSC facilities, even if the latter have scrubbers.

5.1.1.3 Combined Cycle (CC)

Relative to CSC or IGCC, the potential natural and social environmental effects of Combined Cycle generation are moderate. The largest effects are associated with gas extraction (e.g., production, pipeline transport, and gas storage) and air emissions from natural gas combustion (e.g., NOx, CO_2, and carbon monoxide).

Combined Cycle generation burns natural gas very efficiently. As a result, acid gas emissions, particularly SO_2, and CO_2 emissions are lower than those for both CSC (with SCR) and IGCC (Table 5–1). NOx emissions may be slightly higher. These potential adverse effects can be mitigated by controlling NOx emissions (e.g., steam injection, urea injection, selective catalytic reduction) and extensive monitoring. Waste disposal concerns are minimal. There will be concerns about land required for gas extraction, generating sites, transmission, and gas transportation corridors.

From a sustainable development viewpoint, long-term use of scarce, non-renewable resources is not encouraged. Natural gas is more efficiently used in residential heating than in generating electricity. This is one reason why gas-fired generation is used for peaking purposes primarily.

Combined Cycle generation can also produce social and economic effects. The dominant potential effects are those related, directly or indirectly, to increased employment and regional development. These can be addressed with community impact monitoring and impact management agreements. There also may be local lifestyles effects, especially for people in the vicinity of the facility, if there are real or perceived effects on the natural environment. Public reaction to these effects, however, may be moderated by their preference for natural gas-fired generation.

5.1.1.4 Combustion Turbine Units (CTU)

The potential natural and social environmental effects associated with Combustion Turbine Units are similar to those for Combined Cycle. CTU generation has the ability to burn a variety of refined fossil fuels (oil, natural gas, diesel fuel). CTUs are mainly used for peaking purposes, but operate at relatively low efficiencies compared to CC or IGCC. Natural gas will likely be the preferred fuel for CTUs. Among the fossil options, CTUs produce the least natural environmental effects. The largest effects are those associated with long-term use of natural gas, fossil fuel extraction (e.g., pipeline transport and gas storage), air emissions from fossil fuel combustion (e.g., NOx, and carbon monoxide) and noise.

Oil-fired CTUs produce more SO_2 and CO_2 emissions than gas-fired units. NOx emissions for both are considerably higher than for CSC (with SCR), CC or IGCC (Table 5–1). These potential effects can be mitigated by controlling combustion emissions (e.g., steam injection) and through monitoring. Due to the low height at which these combustion emissions are released, ambient air quality criteria may be a concern, particularly in heavily industrialized areas where the airshed is already extensively utilized. On-site noise levels could also be

increased. However, CTU silencer design should minimize any offsite disturbance. Some land will be displaced for fuel extraction, generating sites, transmission corridors, and fuel transport. Waste management concerns will be minimal. Land use concerns will be reduced if CTUs are placed mainly on existing generating station sites.

CTUs, particularly those on existing sites, will have modest effects on the social environment. Principal concerns are likely to be impacts on air quality, health, and recreation. Beneficial effects will include employment and regional development opportunities. Socio-economic effects would likely be more significant in northern or remote communities. These effects can be mitigated or enhanced through emission controls, community impact monitoring and impact management programs, and initiatives for local hiring.

5.1.2 Nuclear Options

The potential effects of nuclear power on the natural environment are primarily related to uranium mining, radionuclide releases, cooling water use, and the management of radioactive wastes.

Typical radionuclide releases from a nuclear plant may include tritium, noble gases, iodine (I_{131}), and radioactive particulates. Radioactive releases may occur in cooling water systems or air exhaust/ventilation systems, as a result of inadvertent discharges and spills, and during transport of contaminated materials. These potential releases are managed through a series of preventive, mitigative, monitoring, and control measures built into the design and operation of each nuclear generating station. These include emergency reactor shutdown, containment (e.g. vacuum building), continuous filtering of air/exhaust systems. Additional protection is provided through designation of a 1 km exclusion zone.

Stringent waste container design and shipment regulations are utilized to prevent potential releases during transport of radioactive materials.

Radionuclide emissions are regulated by the Atomic Energy Control Board (AECB) and must not exceed a site-specific Derived Emission Limit (DEL). Ontario Hydro monitors and controls its emissions, on an annual average basis, to within 1% of the Derived Emission Limit set by AECB.

Annual tritium and noble gas releases are the principal emissions that must be controlled to meet DEL targets. In 1988, tritium releases at Pickering NGS accounted for just over 1% of the DEL (1.12%) while noble gas releases were about 0.15% of the DEL. Only trace amounts of I_{131} and radioactive particulates were released, accounting for less than 0.02% of the DEL.

Tritium is a mildly radioactive beta emitter with a half-life of 12.5 years. To reduce the risk of radiation exposure, a Tritium Removal Facility (TRF) has been constructed at the Darlington NGS site to recover tritium from tritium-contaminated heavy water from all existing Hydro reactors. Noble gases are chemically inert and are not retained in the body for long periods of time.

Deep geologic disposal of high level radioactive wastes (ie., used fuel) is the focus of work being carried out by Atomic Energy of Canada Ltd. (AECL). This disposal concept will be reviewed by a Federal Environmental Assessment Review Panel, starting in 1991. If approved, site selection will start in the

late 1990s. In the meantime, used fuel wastes are being well managed at existing generating stations. The higher volume of low and intermediate level radioactive wastes are managed centrally, using licensed incineration and storage facilities at the Bruce Nuclear Power Development (BNPD).

Significant quantities of wastes are also produced during uranium mining activities and are subject to environmental regulations.

Conventional (non-radiological) effects of nuclear generation relate to cooling water use, emissions from construction/operations machinery and operational refuse.

Expansion of the nuclear program will require increased heavy water production, resulting in increases in low level hydrogen sulphide (H_2S) and sulphur dioxide (SO_2) emissions at BNPD. Preventive monitoring and mitigative measures (eg., flare stacks) are undertaken to control H_2S emission levels.

There are significant land requirements for uranium mining, uranium tailings disposal, generating site development, used fuel/low level radwaste disposal/storage and transmission incorporation.

Most of the socio-economic effects and broad societal considerations related to nuclear generation are similar to those of any large power generation project, but with additional issues associated with nuclear-related health and safety concerns. Some people may choose to change their lifestyles because of their perception of risk; in extreme cases this could prompt them to move to a new community. Public acceptance of nuclear facilities will depend on attitudes at local, regional and provincial levels. Potential socio-economic impacts will be addressed through community impact monitoring and impact agreements.

5.1.3 Transmission Requirements

The land requirement for rights-of-way is the major transmission-related environmental concern.

The overall environmental impact of a transmission line will vary with its length and the types and amounts of resources and land uses encountered. While some land uses such as timber production are displaced by a transmission right-of-way, others such as agricultural crop production may continue with some modifications and inefficiencies. Many impacts can be mitigated by selecting routes that avoid important environmental features, natural resources and land uses. Typically, transmission facilities occupy only a very small percentage of the total ROW area (eg., less than one percent), leaving large areas available for other compatible uses.

5.2 Evaluation of Case Differences

As described in Section 2, each alternative Case considers different combinations of supply technologies (ie., combinations of CTUs, CSC, CANDU units, etc.). While the environmental effects of each of these supply components are described in some detail above, this section focuses on the differences in environmental effects, natural and social, among the major supply Cases under the median load forecast.

For the natural environment, estimates of resource use and emissions/effluents/waste production were derived by applying the criteria outlined in Section 3.3.1 to develop a series of emission/use factors (see Appendix A). These factors are used to equate total or fuel-specific energy production in a particular Case with a resulting environmental effect. This effect is assumed to be directly proportional to the amount of emission released or resource

Cumulative Effects 1989 - 2014 Natural Environment

Criterion	Case					
A. Resource Use	**23**	**22**	**15**	**24**	**26**	**Units**
Non-Renewables: Fuel						
1. Coal	131.0	176.0	228.0	255.0	341.0	Tg
2. Oil	0.3	0.8	1.7	2.4	3.5	Gl
3. Gas	0.0	30.0	252.0	327.0	519.0	Gm^3
4. Uranium	57.0	55.0	53.0	51.0	46.0	Gg
Non-Renewables: Other						
1. Limestone (for FGD)	2.6	3.6	4.2	5.7	10.8	Tg
Water Use						
1. Water (Generation Related)	567.0	555.0	541.0	530.0	504.0	Gm^3
2. Water (Life Cycle)	1.57	1.55	1.54	1.51	1.50	Tm^3
Land Use						
1.Land (Generation Related)	17.2	15.3	15.4	15.5	15.8	$Ha10^3$
2.Land (Life Cycle)	59.0	60.0	63.0	66.0	72.0	$Ha10^3$
B. Emissions / Effluents / Wastes						
Atmospheric Emissions						
1. SO_2	2.0	2.6	3.0	3.1	3.2	Tg
2. NOx	0.5	0.6	0.8	0.8	1.0	Tg
3. Total Acid Gas (SO_2+ NOx)	2.5	3.2	3.8	3.9	4.2	Tg
4. CO_2	325.0	419.0	523.0	590.0	815.0	Tg
5. Radionuclides	7.5	7.2	6.9	6.8	6.0	$Ci10^6$
6. Trace Elements	17.0	23.0	30.0	34.0	48.0	Gg
7. Particulates	6.5	8.7	11.0	12.4	17.3	$Mg10^6$
Aquatic Effluents						
1. Thermal Discharge	24.7	24.3	24.0	23.7	23.0	$Tj*10^6$
2. Radionuclides	4.4	4.2	4.1	4.0	3.6	$Ci10^6$
3. Uranium Mining Effluent	8.4	8.1	7.7	7.5	6.8	Tg
4. Coal Mining Effluent	0.5	0.7	0.8	0.9	1.3	Tg
Wastes						
1. Coal Ash	12.5	16.8	22.4	24.7	31.8	Tg
2. FGD Wastes	4.8	6.7	7.9	10.8	20.6	Tg
3. Used Nuclear Fuel	57.5	55.3	52.9	51.4	46.6	Gg
4. Low Level Radioactive Waste	23.0	22.1	21.2	20.6	18.6	Gg
5. Uranium Mine Tailings	36.2	34.9	33.3	32.4	29.3	Tg
6. Total Wastes	53.7	58.4	63.7	67.9	81.8	Tg

used. For example, the amount of coal-fired generation will determine the amount of land disturbed for coal mining, levels of acid gas emissions, and ash/FGD waste volumes. Estimates for all the Cases are summarized in Table 5-2 and Figures 5-1 to 5-7. For the most part, these estimates provide information on cumulative resource use and emissions/effluents/ wastes for the entire study period, 1989 to 2014. In a number of Cases (Figures 5-4 and 5-5), annual estimates are provided to illustrate certain implications (e.g., compliance with acid gas emission regulations).

In addition to estimates for all Cases, a series of indices (Figures 5-8 to 5-17) are developed for each natural environment criterion group, to evaluate the normalized performance (on a per TWh basis) of each Case over the study period. These estimates are utilized to assess the relative natural environmental implications of each alternative Case and provide a basis for comparing the Cases.

Social criteria are applied less quantitatively. Judgments on potential impacts are largely based on past experience at Hydro and other large industrial development projects in Ontario.

The implications of changes in load growth, assumed planning period, proposed regulatory changes (e.g., CO_2 emission limits, zero discharge, waste reduction targets), and siting on Case performance are discussed in Section 5.3. Opportunities for avoiding or mitigating potential environmental effects of alternative Cases are addressed in Section 6.0.

5.2.1 Case 23

5.2.1.1 Natural Environmental Impacts

Resource Use

Case 23 is characterized by the heavy reliance on nuclear generation, and as such, has the lowest consumption of non-renewable coal, oil and gas resources among the alternative Cases (Figure 5-1). Uranium use is higher [10-23%] than for all other Cases. The fact that uranium use is not significantly different among Cases reflects the continued reliance in all Cases on the existing nuclear component, up to and including Darlington, to supply a large portion of the system load during this study period. Normalized coal use declines over the study period (Figure 5-8), while natural gas and oil use are negligible. Uranium use increases slightly over the study period.

Life cycle (mining to waste disposal) water use (Figure 5-2) for this Case is slightly higher [up to 4%] than that for all other alternative Cases, while cooling water requirements are noticeably higher [6-12 %] than fossil-based Cases and marginally higher [2-5 %] than Case 15 and the other nuclear-based Case (Case 22). The higher water requirements of Cases 22 and 23 reflect the higher cooling water flows associated with nuclear, versus fossil generating stations. Life cycle requirements become more similar with the inclusion of water use for both uranium and coal mining. Normalized water use decreases over the planning period (Figure 5-8).

Life cycle land displacement (Figure 5-3) associated with this Case is the lowest among the alternative Cases, reflecting lower mining and waste disposal requirements for the nuclear

Figure 5–1 **Non–Renewable Resource Use-Median Load Forecast**

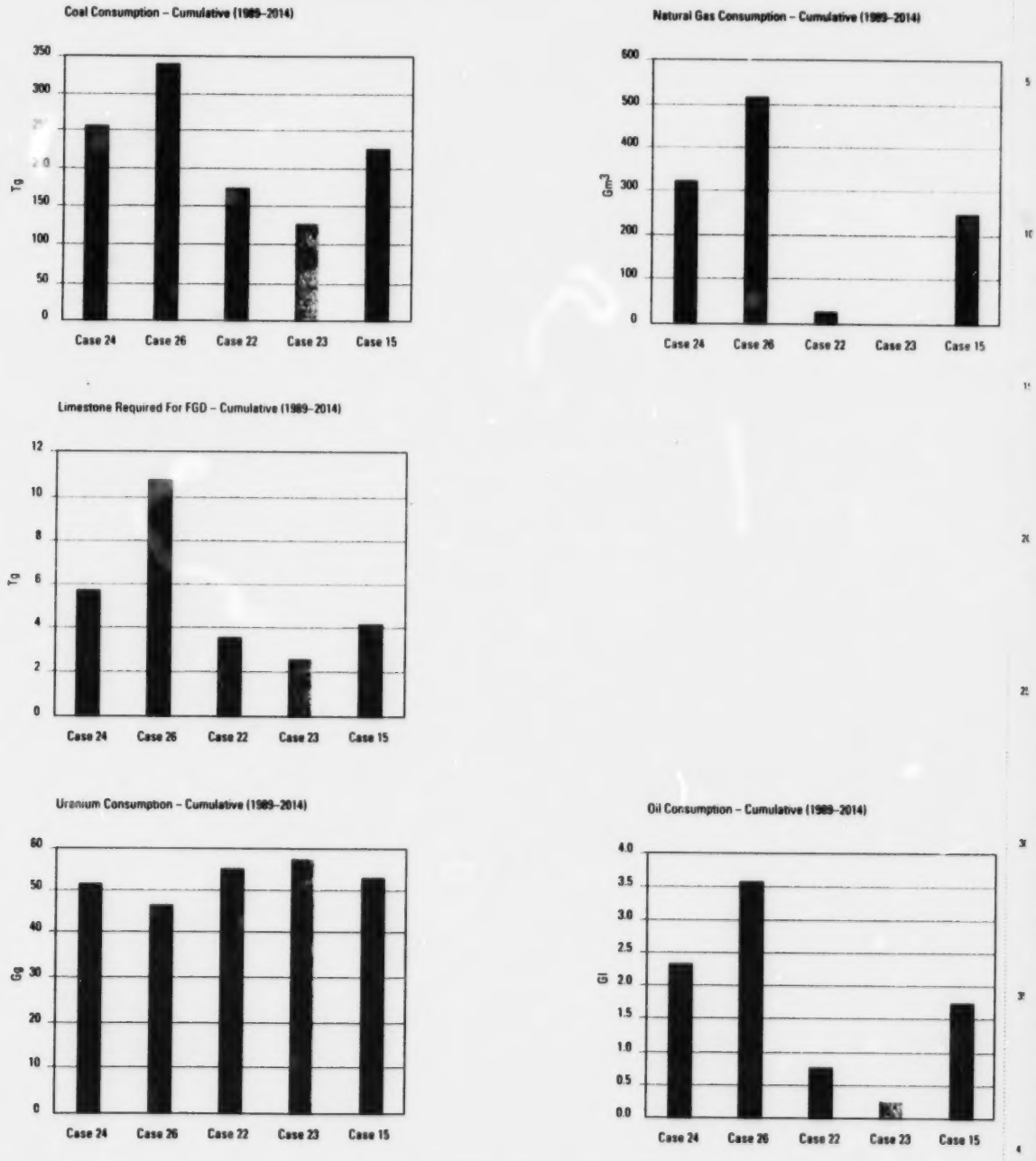


Figure 5–2 **Water Use–Mining and Generation–Median Load Forecast**

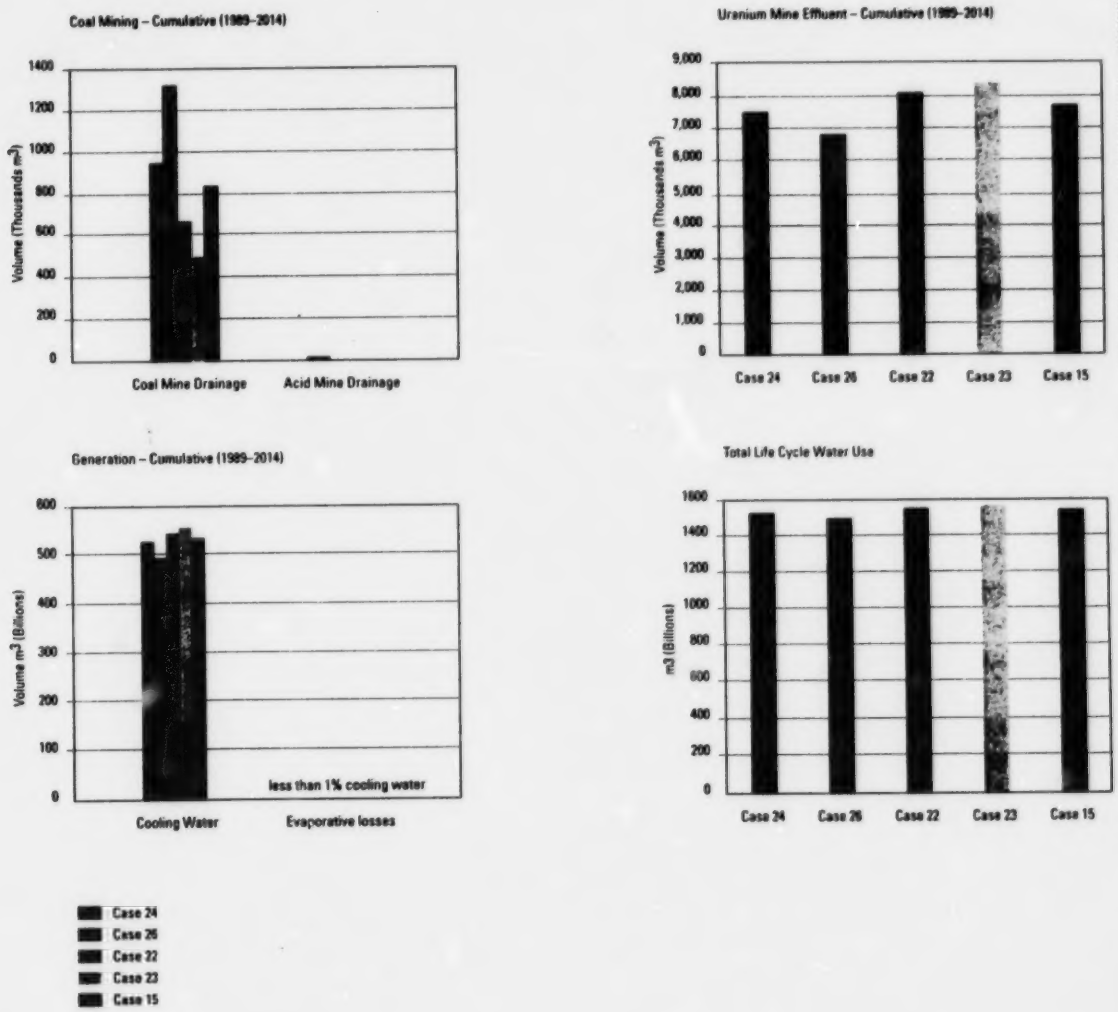


Figure 5–3 **Land Use–Median Load Forecast**

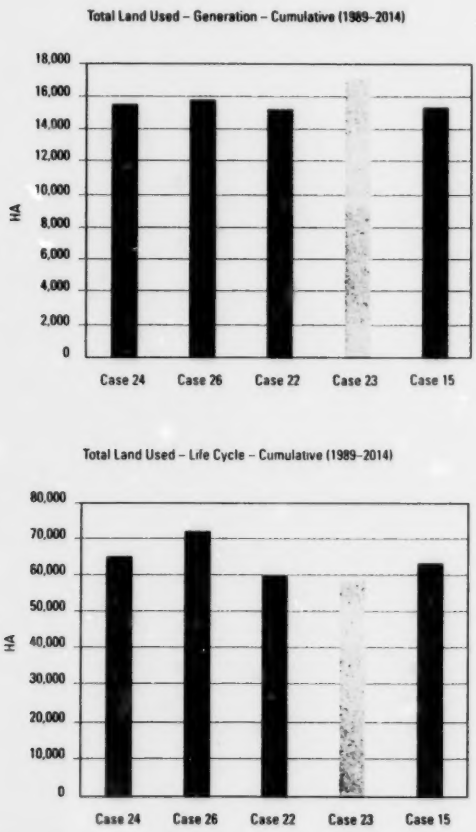
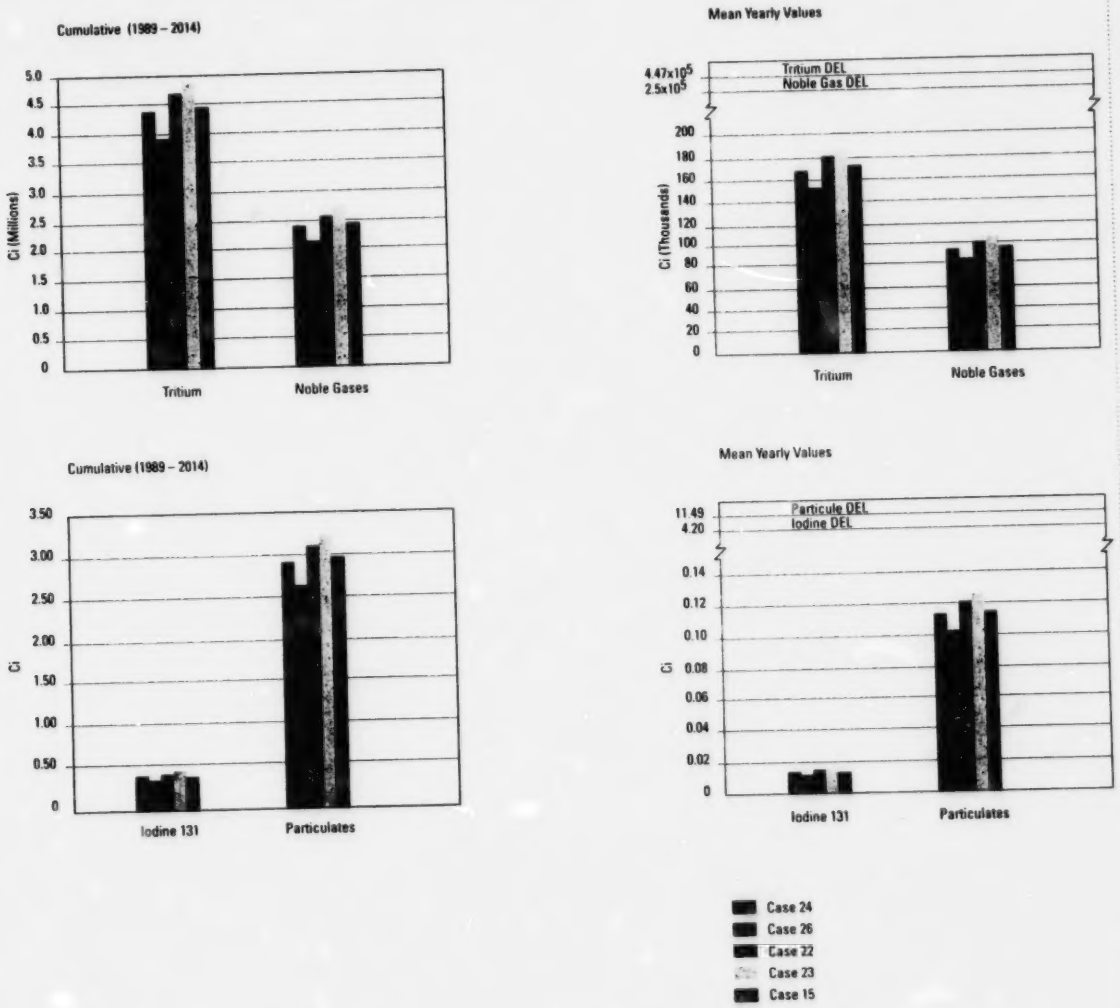


Figure 5–4 **Atmospheric Emissions (Radionuclides)–Median Load Forecast**



option. Generation-related land displacement is the highest among all the Cases. This higher land use is related to a comparatively higher need for additional new generating sites and associated transmission. Normalized land use declines throughout the planning period, (Figure 5–8).

Emissions/Effluents/Wastes

Heaviest reliance on nuclear generation results in this Case having the lowest acid gas (SO_2 + NOx), CO_2, particulate and trace element emissions among the alternative Cases (Figure 5–5). Normalized emissions for these parameters decrease steadily over the planning period (Figure 5–9).

It should be noted, however, that all Cases meet current regulatory limits for SO_2, NOx and total acid gas (SO_2 + NOx) emissions, for the median load and upper load forecasts, over the study period.

However, since acid gas emissions for this Case are the lowest among the alternative Cases, there is additional margin with respect to regulatory limits (Figure 5–5).

Aquatic effluent levels (including thermal discharges) are marginally higher for Case 23 than for the other Cases (Figure 5–6). Normalized values increase slightly over the study period (Figure 5–9).

Total waste production levels are lowest for this Case, although radioactive wastes are higher [10-23 %] than all other Cases (Figure 5–7). Normalized, total waste production rates decrease for this Case over the study period (Figure 5–9).

High waste production in all Cases reflects the continued system reliance on existing generation sources (particularly older fossil units) during the study period. The addition of Flue Gas Desulphurization and increased use of low-sulphur coal at existing coal-fired stations add significantly to waste inventories in this period. Opportunities to reduce this growing waste inventory through aggressive waste recycling and reuse programs (e.g., commit to production of FGD gypsum) are being pursued.

Annual radionuclide emission levels for all Cases (Figure 5–4) remain well within regulatory requirements and corporate targets (i.e., 1% of Derived Emission Limits). Total radionuclide emissions and effluents are higher [10-23 %] than for other Cases due to greater dependence on new nuclear units. Normalized radionuclide emissions/effluents increase slightly over the study period (Figure 5–9).

5.2.1.2 Social Environmental Impacts

Socio-Economic Effects

Regional Employment

Case 23, with the highest nuclear component, will have a high level of employment in the construction and operation of four new stations. These projects will require a highly skilled workforce over a 16-18 year construction period. The level of local and regional employment will depend on the availability of skilled workers and initiatives for local hiring and training. Significant indirect employment will also be created in businesses supplying the project and in the retail and service sectors throughout the area.

Regional Economic Development

In order to maximize the regional development benefits of this Case, special initiatives will likely be required in most areas. These initiatives could include agreements with trade unions

and the provincial and federal governments to increase local hiring, provide training, or to assist local businesses in competing for project contracts. Construction camps, if required, may reduce opportunities for investment and indirect employment in surrounding communities. However, some benefits will result from the building, operation, and purchasing associated with such camps.

Nuclear projects provide the opportunity for industrial development using waste heat energy.

Local Community Impacts

With this Case, there will be a large influx of project workers and others required for indirect employment in retail, service and project-related businesses. This influx will likely require the expansion of municipal facilities and services. Population growth and expansion of facilities and services may be considered benefits in communities seeking economic growth and diversification. However, the pace and timing of change may result in adverse effects in some areas. A comprehensive community impact management program, supported by a community impact agreement, will be undertaken to mitigate any adverse impacts.

Societal Considerations

Social Acceptance

The social acceptance of the Cases will depend on the choice and mix of technologies and will be a function of perceived health and safety risks and the public's familiarity with a particular technology.

Special/Sensitive Groups

The inclusion of four nuclear facilities in this Case will be of particular concern to environmental and nuclear interests. The safety of nuclear facilities and the management of nuclear waste will be the main concerns. Special attention will have to be paid to issues such as employment and economic opportunities for Native and other local people. Local preferences and lifestyles will also be considered in the construction and operation activities.

Lifestyle Impacts

Case 23 is unlikely to lead to significant changes in lifestyle for the majority of Ontarians. However, some people may choose to change their lifestyle because of their perception of risk and in extreme cases this could prompt them to move to a new community.

The lifestyle of residents in less developed areas of the province may change because of the influx of new residents, changing employment patterns (i.e., construction employment vs. traditional occupations), increased availability of goods and services, and changing municipal services. These changes can be positive or negative and will be particularly significant for Native people who have followed a traditional way of life.

Distribution of Risks and Benefits

Those who perceive that they are exposed to risks at any stage of the fuel cycle or from transportation of nuclear materials, but do not perceive a compensating benefit, may consider that situation inequitable. Concerns about the sharing of risks and benefits from nuclear facilities may be raised by: those living near the site and those living away from that site; those living near nuclear material transportation routes and those living away from those routes; and those concerned about future generations having responsibility for long-term management of nuclear waste.

Figure 5–5 **Atmospheric Emisssions (Conventional)–Median Load Forecast**

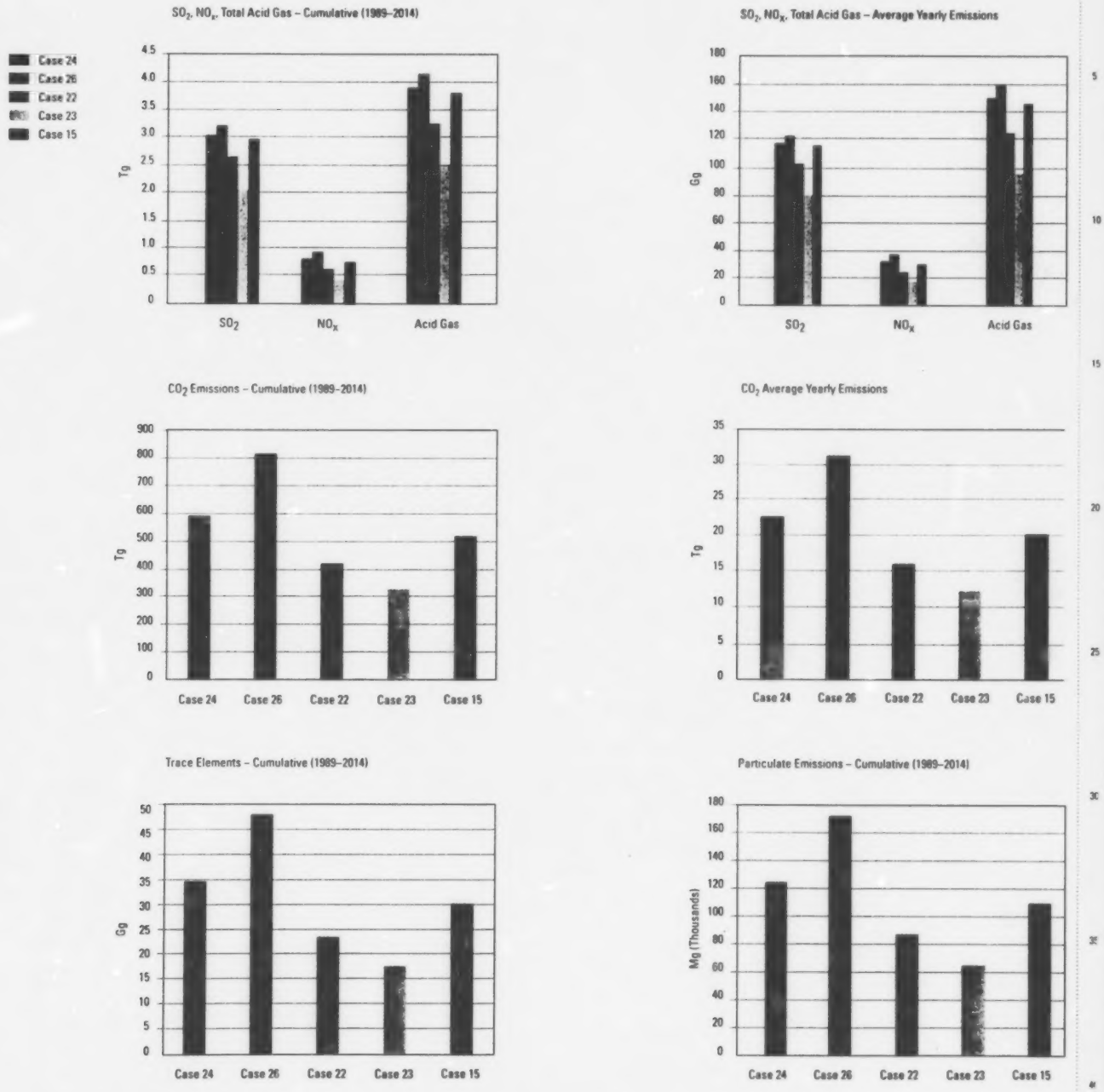
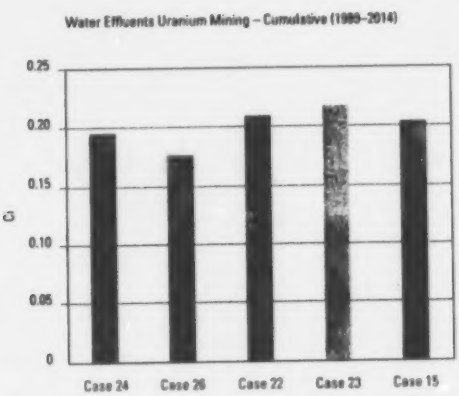
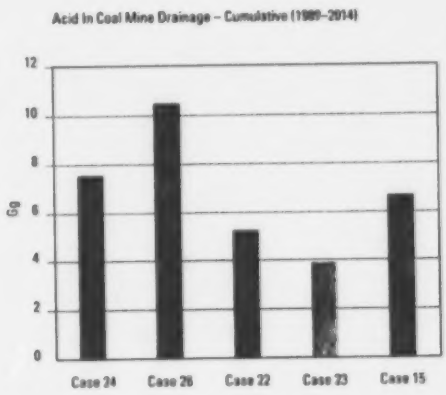
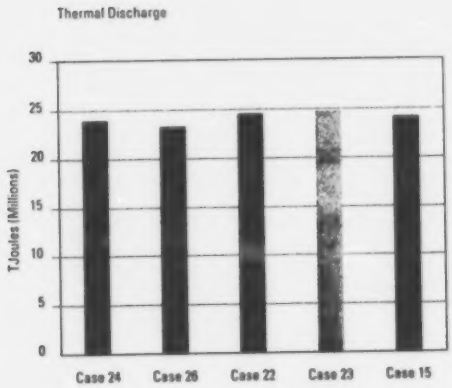
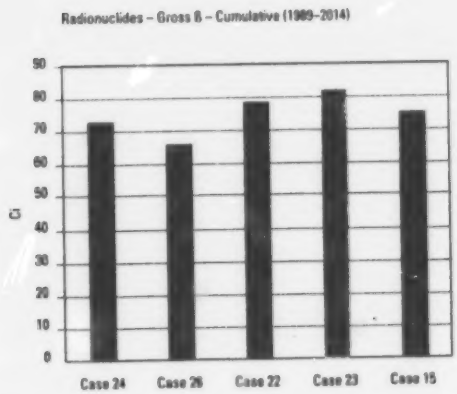


Figure 5–6 **Water Effluents–Median Load Forecast**









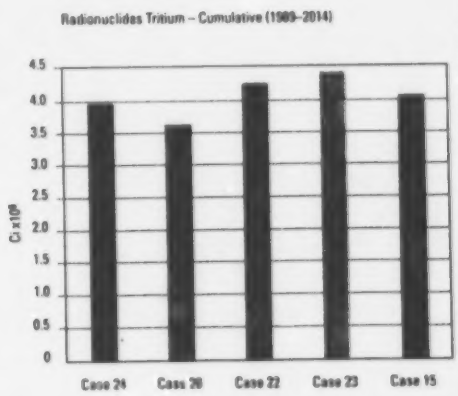
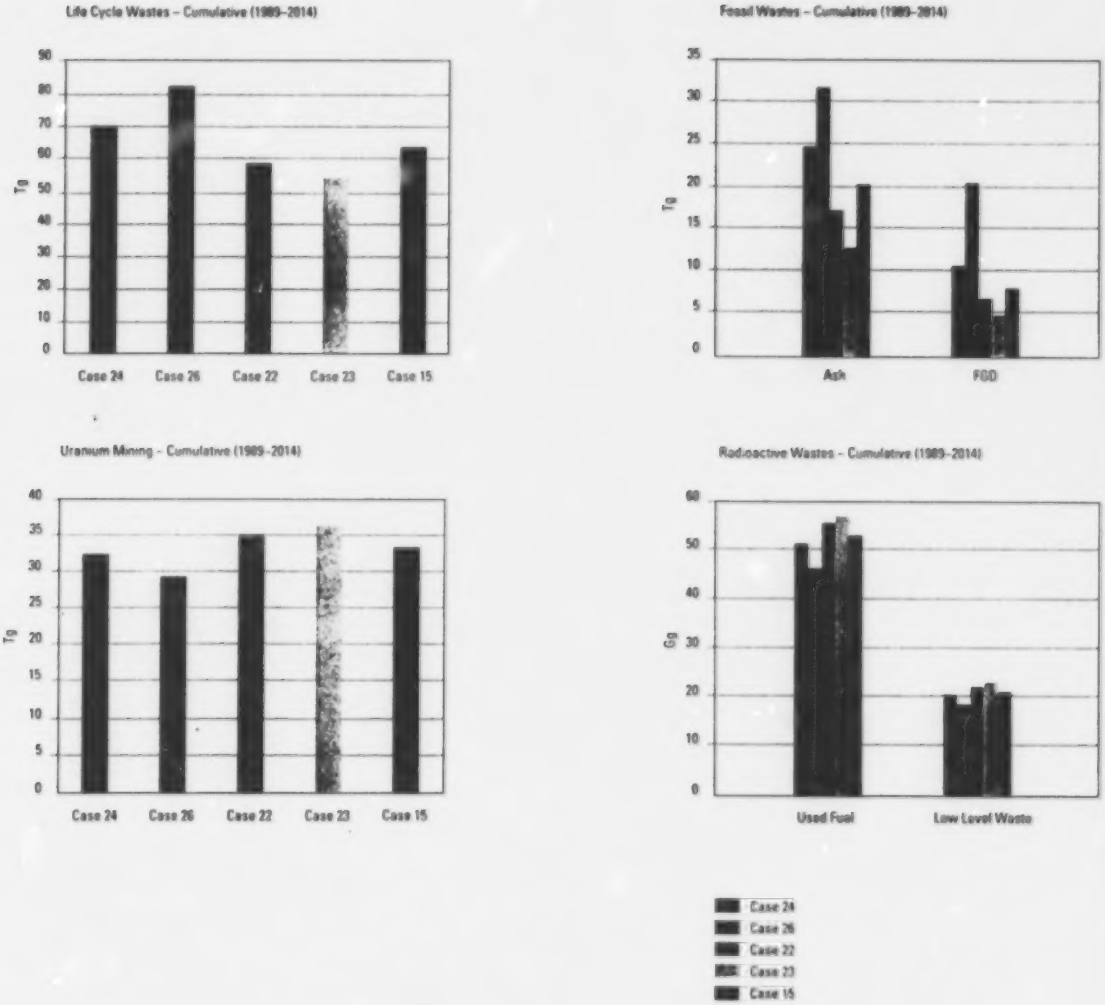


Figure 5–7 **Waste Production–Median Load Forecast**



5.2.2 Case 22

5.2.2.1 Natural Environmental Impacts

Resource Use

Like Case 23, Case 22 is characterized by significant reliance on nuclear generation, and, as such, has significantly lower consumption of non-renewable coal, oil and gas resources (Figure 5–1). Uranium use is marginally higher than for Case 15 and the two fossil Cases, but slightly less [5%] than for Case 23. Normalized coal use decreases over the study period (Figure 5–10), while natural gas and oil use are negligible. Uranium use increases slightly during the planning period.

Life cycle water use (Figure 5–2) for this Case is similar to that of all other alternative Cases. However, cooling water requirements are marginally higher [3-10%] than those for Case 15 and the two fossil Cases, but only slightly less [2%] than the requirements for Case 23. The higher requirements of Cases 22 and 23 reflect the higher cooling water flows associated with nuclear generation, versus fossil generating stations. Normalized water use decreases slightly over the planning period (Figure 5–10).

Life cycle land displacement (Figure 5–3) associated with this Case is lower than Case 15 and the two fossil Cases, reflecting lower mining and waste disposal requirements for the nuclear option. Generation-related land displacement, excluding mining, is lowest among all Cases, including Case 23. Case 22's better rating, in comparison to Case 23, is related to reduced demand for new generating sites and associated transmission. Normalized land use declines throughout the planning period, (Figure 5–10).

Emissions/Effluents/Wastes

Reliance on nuclear generation results in this Case having relatively low acid gas, CO_2, particulate and trace element emissions (Figure 5–5). Normalized emissions for these parameters decrease steadily over the planning period (Figure 5–11).

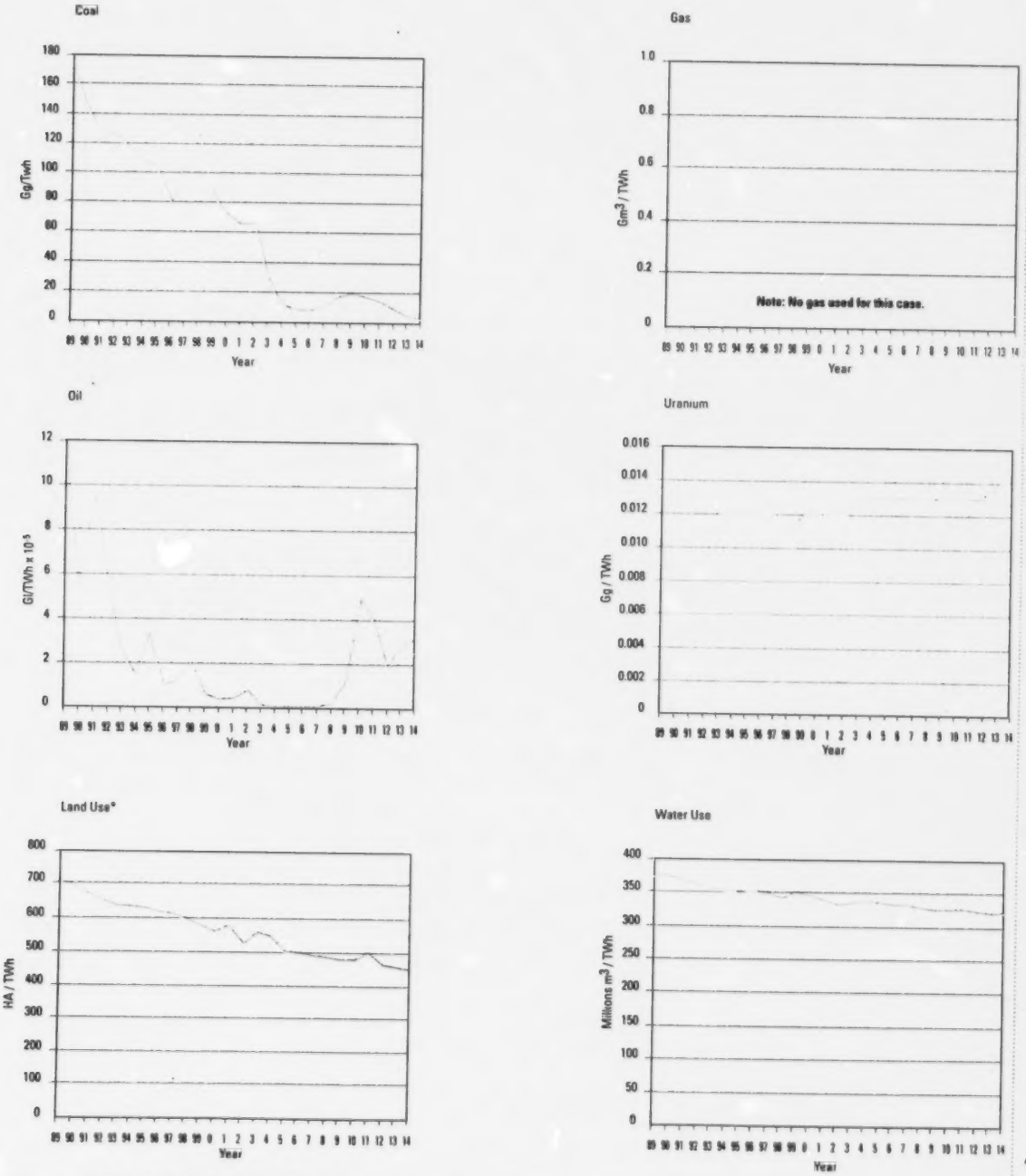
As noted earlier, all Cases meet regulatory limits for SO_2, NOx and total acid gas (SO_2 + NOx) emissions, for the median load and upper load forecasts, over the study period (Figure 5–5). However, since acid gas emissions for Case 22 are comparatively low, there is significant margin with respect to current regulatory limits.

Aquatic effluent levels (Figure 5–6) are slightly less [1%] than for Case 23 and slightly higher [2-6 %] than those for the other remaining Cases. Like Case 23, normalized water use decreases slightly over the planning period (Figure 5–10).

Total waste production levels (Figure 5–7) are slightly higher than Case 23, but significantly less than those for the remaining three Cases, particularly fossil-based Cases. Normalized waste production decreases over the planning period (Figure 5–11).

Annual radionuclide emission levels for all Cases remain well within regulatory requirements and corporate targets (ie., 1% of Derived Emission Limits). Total radionuclide emissions/effluents and radioactive waste production are marginally higher for Case 22, versus all other Cases except Case 23, due to dependence on new nuclear units. Normalized radionuclide emissions/effluents and wastes increase over the study period (Figure 5–11).

Figure 5–8 **Case 23–Resource Use Indices–Median Load Forecast**



* Includes all Ontario Hydro–owned property prior to 1988

Figure 5–9 **Case 23–Emission/Effluent/Waste Indices–Median Load Forecast**

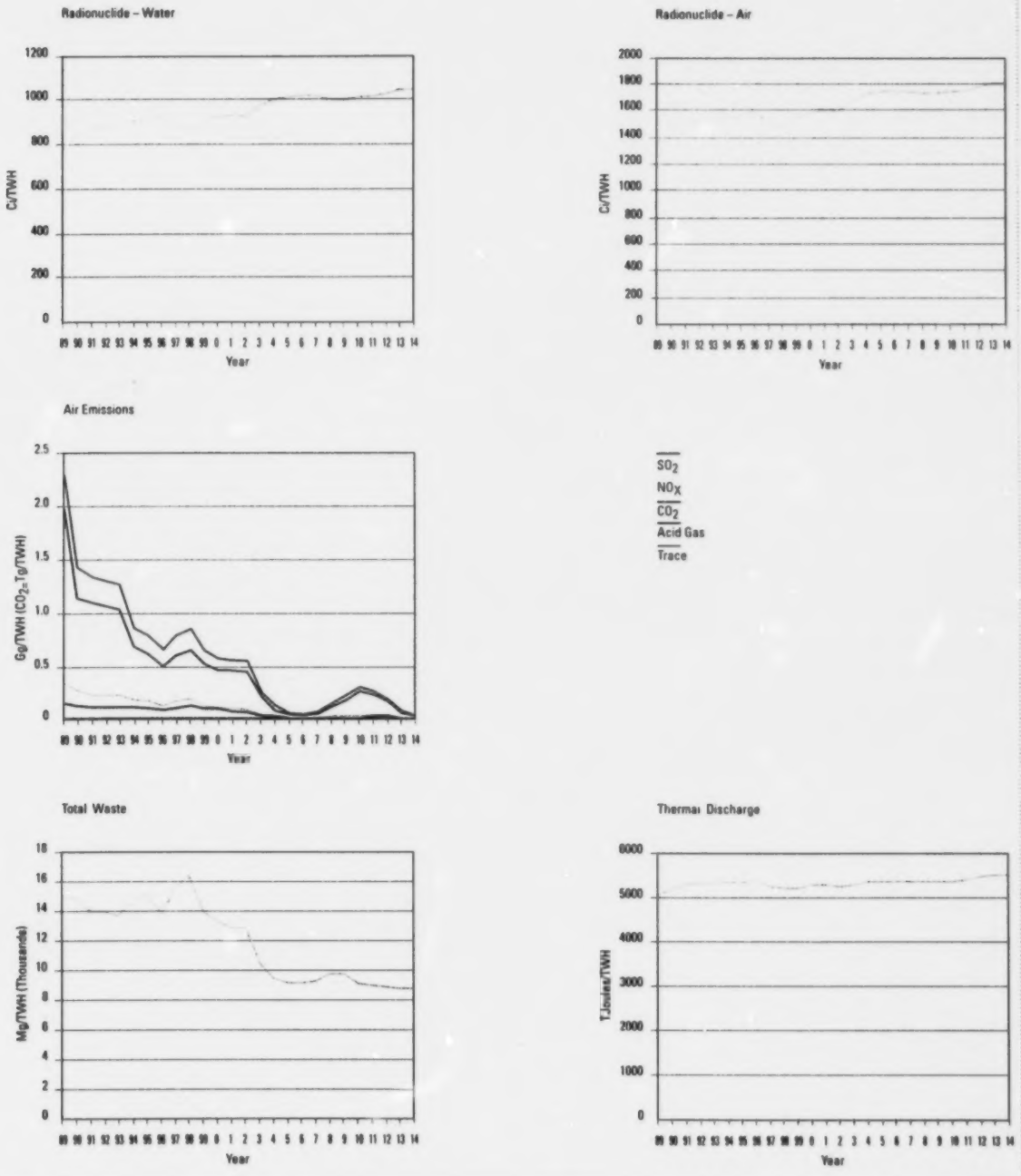


Figure 5–10 **Case 22–Resource Use Indices–Median Load Forecast**

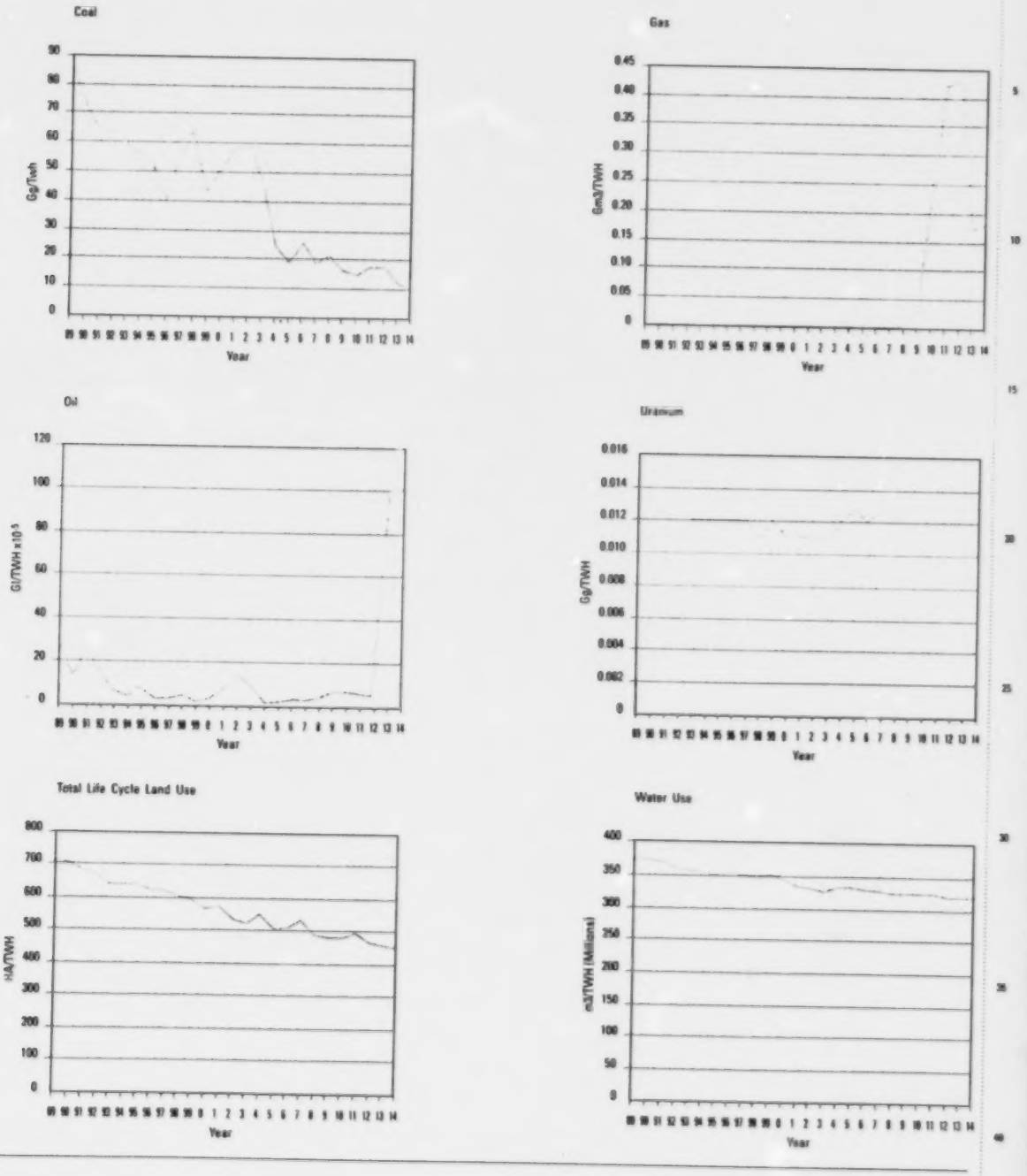
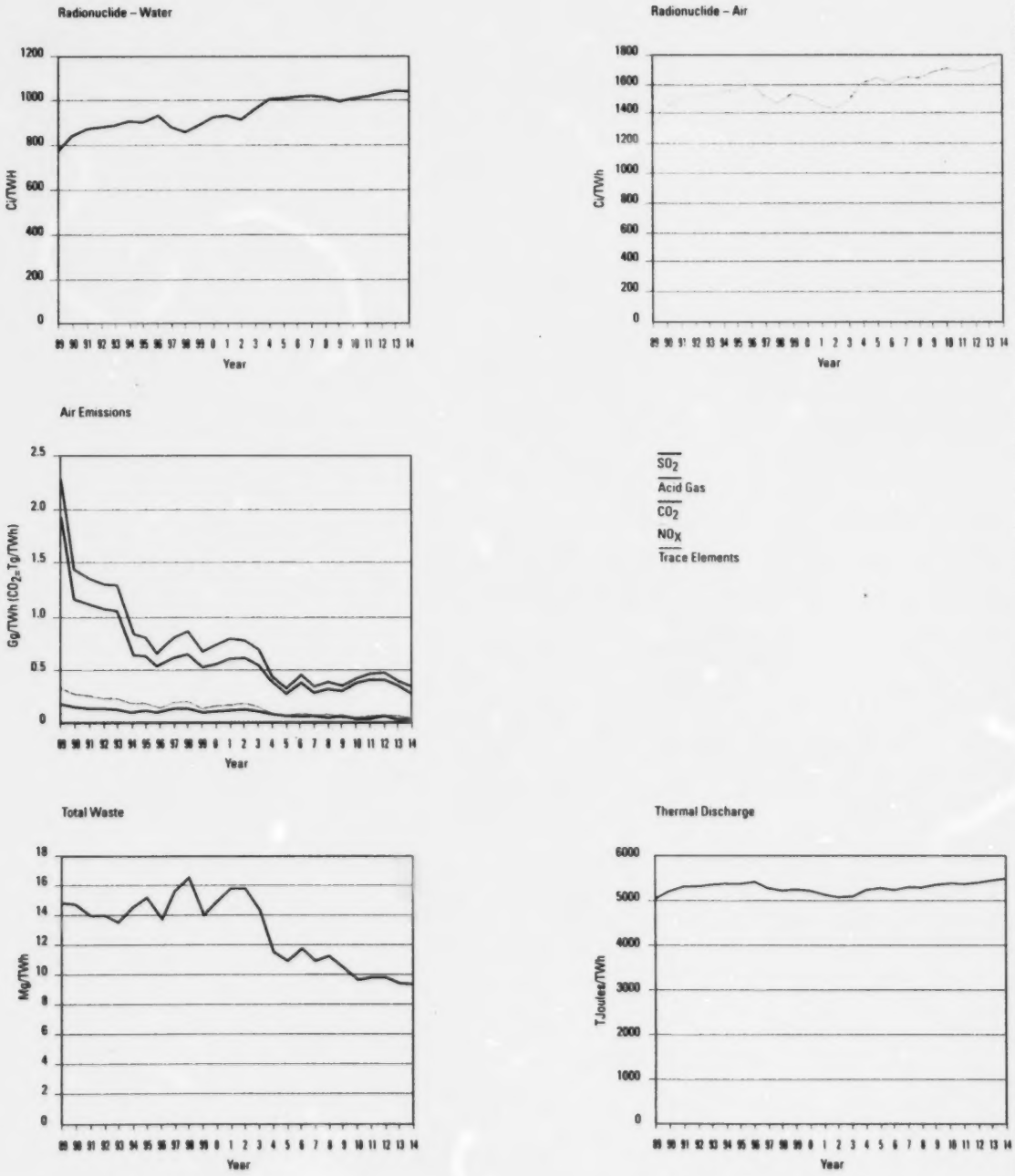


Figure 5–11 **Case 22 – Emission/Effluent/Waste Indices–Median Load Forecast**



5.2.2.2 Social Environmental Impacts

Socio-Economic Effects

Regional Employment

Case 22, with its large nuclear component, will also have a high level of employment in the construction and operation of three stations. These projects will require a highly skilled workforce over a 10-12 year construction period. The level of local and regional employment will depend on the availability of skilled workers and initiatives for local hiring and training. Significant indirect employment could be created in businesses supplying the project and in the retail and service sector.

Because of the smaller scale and shorter duration of construction with CTU and CTU/CC projects, relatively less employment is generated than for other facilities. There is also likely to be limited indirect employment created.

Regional Economic Development

In order to maximize the regional development benefits of most of these projects, special initiatives will be required in most areas. These initiatives could include agreements with trade unions and the provincial and federal governments to increase local hiring, to provide training, or to assist local businesses in competing for project contracts. However, the establishment of construction camps for any of these facilities may reduce opportunities for investment and indirect employment in surrounding communities. Nuclear projects provide the opportunity for industrial development using waste heat energy.

The smaller scale and shorter duration of construction with CTU and CTU/CC projects would provide little opportunity for regional development. The exception would be a large CTU/IGCC project. A phased construction program may provide employment opportunities over a longer period of time and therefore encourage additional regional economic development.

Local Community Impacts

The differences in local community impacts will depend on the type of generation facility, the workforce size and related in-migration, and the resultant municipal infrastructure requirements. Location of nuclear facilities in less developed areas of the province will create significant effects. Even with initiatives to encourage local hiring and the use of a construction camp, there would be an influx of project workers and employees in retail, service and project-related businesses. This influx would likely require the expansion of municipal facilities and services. A comprehensive community impact management program, supported by a community impact agreement, will be undertaken to mitigate these effects.

Local community impacts for projects in more developed areas would tend to be moderate because of the availability of a large local and regional workforce and the existing infrastructure. A community impact agreement will be undertaken to manage or mitigate adverse effects.

Local community impacts for CTU and CTU/CC projects are likely to be minor. Local impacts are therefore likely to be related to construction effects such as increased traffic, road damage and noise. In addition, if CTUs are built and converted to CC in stages, resulting in lower peak construction activity, then the effects on communities may be lessened. There is likely to be little or no in-migration of project

workers. However, there may be pressure on temporary accommodation facilities if project workers commute. Impact agreements to offset specific project effects may be required.

Societal Considerations

Social Acceptance

The social acceptance of Case 22, with its reliance on nuclear generation, will also be influenced by the public's perception of risk. The fossil components of this Case are likely to be more socially acceptable if they are converted to CC units.

Special/Sensitive Groups

The inclusion of three nuclear facilities in this Case will be of particular concern to environmental and nuclear interests. The safety of nuclear facilities and the management of nuclear waste will be the main focus of concern. Project EAs will deal with site specific effects and will address in detail issues such as employment and economic opportunities for Native and other local people.

Fossil components of Case 22, although less than with other alternatives, are likely to be of concern to environmental and recreation interests and to resource industries, such as agriculture and forestry, potentially affected by acid and greenhouse gases and ozone levels. The increased reliance on gas or oil for CTUs, particularly if they are not converted to CC and IGCC, will be of concern to environmental, conservation, and energy interest groups.

Lifestyle Impacts

Case 22 is unlikely to lead to significant changes in lifestyle for the majority of Ontarians. However, some people may choose to change their lifestyle because of their perception of risk and in extreme instances this could prompt them to move to a new community.

The lifestyle of residents in smaller communities would likely change with the influx of new residents, changing employment patterns (ie., construction employment vs. traditional occupations), increased availability of goods and services, and changing municipal services. These changes can be positive or negative and will be particularly significant for Native people who have followed a traditional way of life.

Distribution of Risks and Benefits

Those who perceive that they are exposed to risks, but who do not receive a compensating benefit, may consider that situation inequitable. Concerns about the sharing of risks and benefits from nuclear facilities may be raised by: those living near a site and those living away from that site; those living near nuclear material transportation routes and those living away from those routes; and those concerned about future generations having responsibility for long-term management of nuclear waste.

5.2.3 Case 15

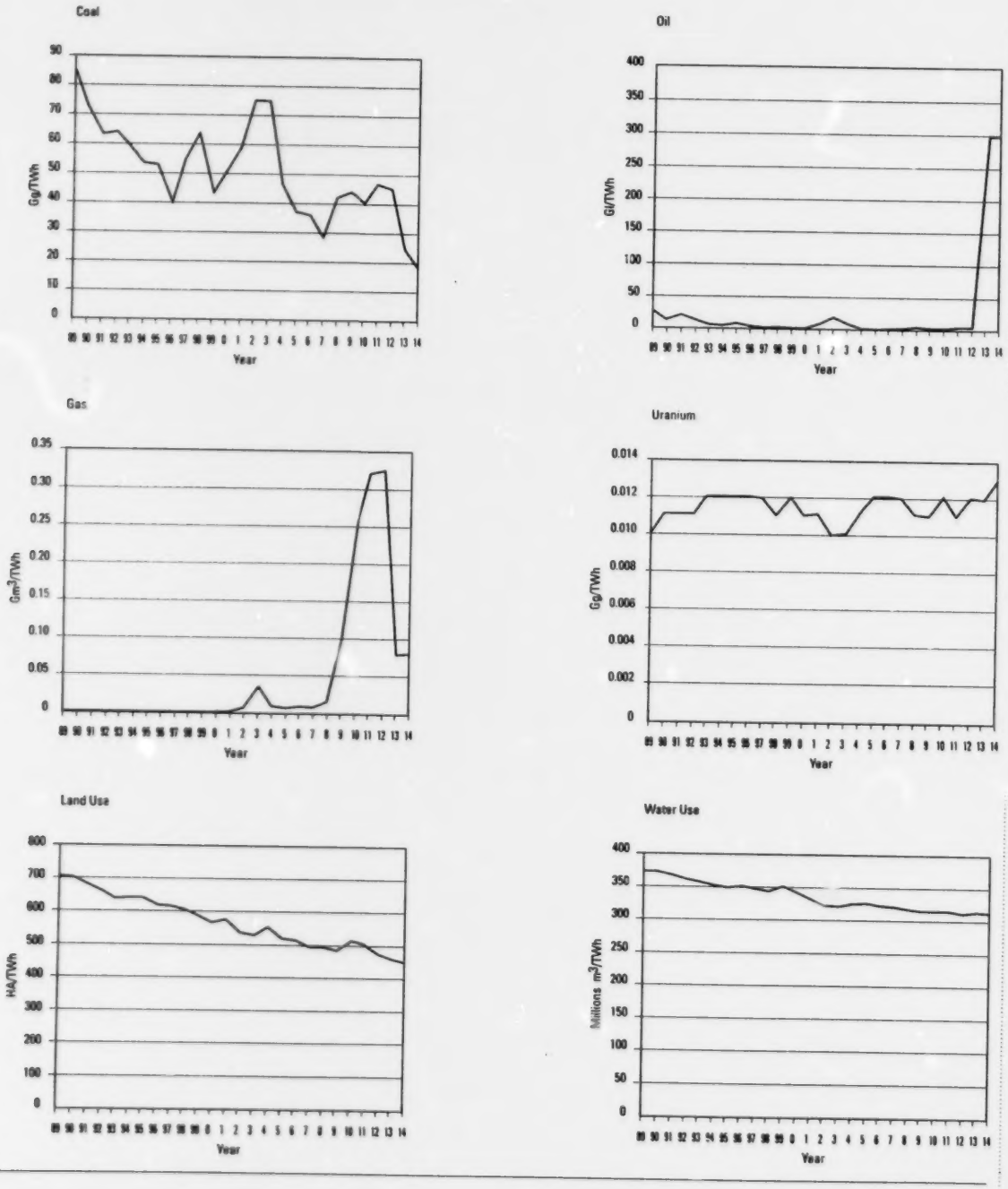
Case 15 represents a "middle ground" among the alternative Cases, with intermediate levels of resource use and emissions/effluents and waste production and a balancing of the social effects of nuclear and fossil projects.

5.2.3.1 Natural Environmental Impacts

Resource Use

Non-renewable resource use is slightly higher than in the nuclear-based Cases and lower than in the fossil-based Cases (Figure 5–1). Normalized coal use declines over time, while

Figure 5–12 **Case 15 – Resource Use Indices–Median Load Forecast**



use of oil and gas is minimal until the latter part of the study period (Figure 5–12). Uranium use increases slightly over the study period (Figure 5–12).

Total life cycle land use is noticeably less [4-16%] than for the fossil-based Cases and marginally higher [5-7%] than for the two nuclear-based Cases. Normalized land use fluctuates throughout the study period (Figure 5–12) in response to additions of new sites and associated transmission, but shows a decline by the year 2014.

Life cycle water use is only slightly higher [2 %] than in the fossil-based Cases and slightly lower [1-2%] than in the two nuclear-based Cases. Normalized water use (Figure 5–12) declines slightly over the study period.

Emissions/Effluents/Wastes

Acid gas emissions (SO_2, NOx) are marginally higher than in the nuclear-based Cases and marginally lower than in those for fossil based Cases (Figure 5–5). Differences in CO_2, particulate and trace element emissions tend to be more significant. Normalized atmospheric emissions decline steadily over the study period (Figure 5–13).

Aquatic effluents, primarily thermal discharge from generation (Figure 5–6), are slightly lower [2-3 %] than for nuclear-based Cases and slightly [1-4%] higher than for fossil-based Cases. Effluents from uranium mining and coal mining are intermediate, relative to nuclear and fossil based Cases. Normalized effluent levels increase slightly over the planning period (Figure 5.13).

Radionuclide emissions/effluents (Figures 5–4 and 5–6) are marginally [5-9%] lower than the nuclear-based Cases and noticeably higher [4-14 %] than for fossil-based Cases. Normalized radionuclide values increase slightly over the period (Figure 5–13).

Life cycle waste production (Figure 5–7) is higher [10-19%] than for the two nuclear-based Cases and lower [8-33%] than the fossil-based Cases. Significant differences in fossil-derived wastes are apparent. Normalized waste production (Figure 5–13) declines over the study period.

5.2.3.2 Social Environment Impacts

Socio-Economic Effects

Regional Employment

Case 15 provides an intermediate level of employment in comparison to the alternative Cases. Location of a facility in a less well-developed area of the province would likely result in more indirect employment because of the development of local businesses, both project-related and in the retail and service sector. A facility located in more densely populated areas of the province would be able to draw mainly on a local and commuting workforce, while a station in more remote and less populated areas would require the in-migration of project and other workers.

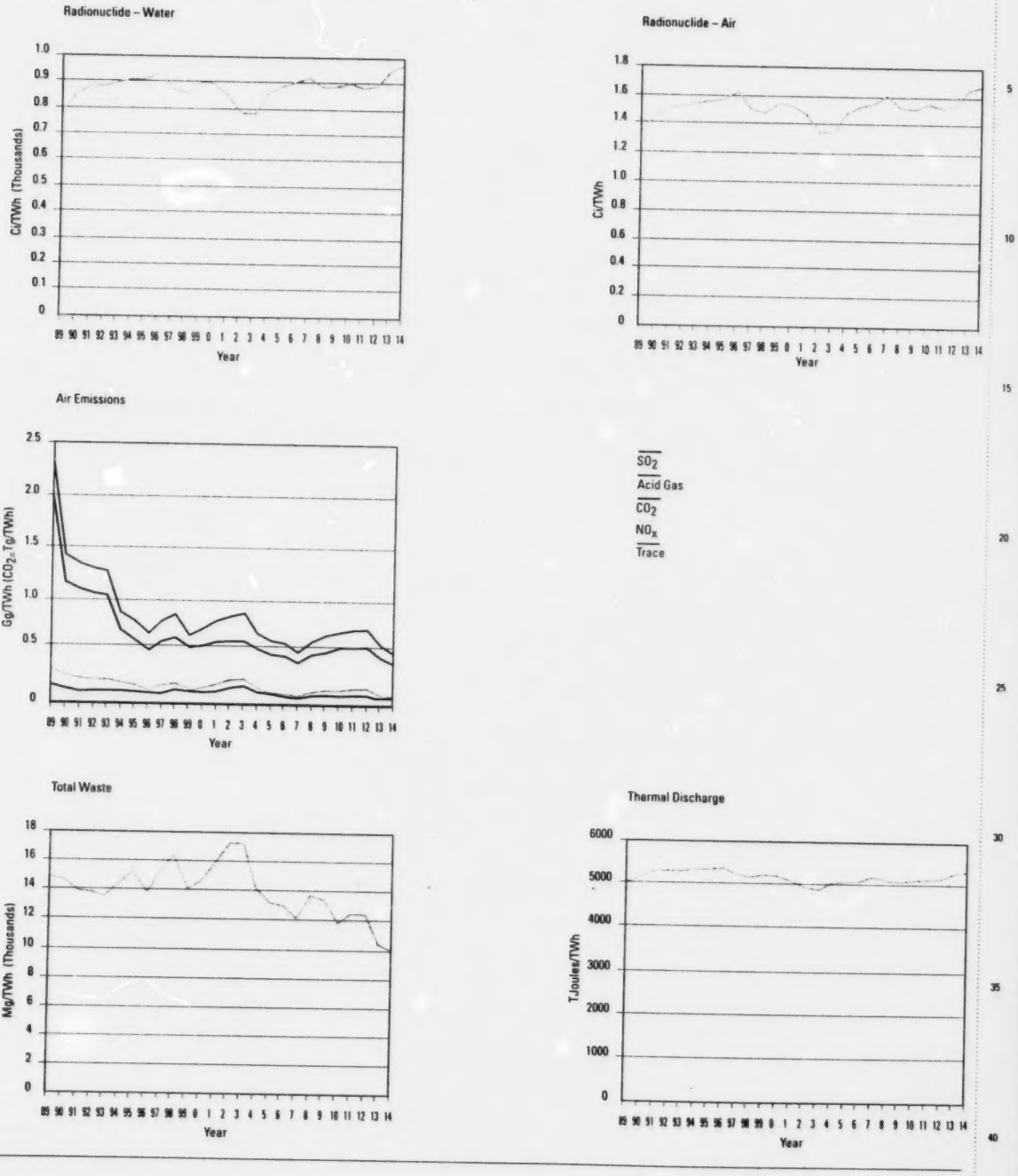
Both IGCC and nuclear developments will create significant employment benefits. CTU projects will provide only limited employment.

Regional Economic Development

The nuclear facilities in Case 15 would provide the opportunity for significant regional development benefits.

Case 15 includes the development of an IGCC facility. A large scale IGCC plant would also provide a significant boost to a regional economy.

Figure 5–13 **Case 15–Emission/Effluent/Waste Indices–Median Load Forecast**



Case 15 also provides the opportunity for heat-energy development in conjunction with the operation of nuclear facilities.

As in other Cases, special initiatives would be required to maximize regional development benefits.

Local Community Impacts

The main potential for community impacts from the development of nuclear facilities will be areas of the province which have a less well-developed community infrastructure to support the in-migration of workers and their families and the growth in the retail and service sector. A comprehensive community impact management program, supported by a community impact agreement, will be undertaken to mitigate these effects.

Local community impacts for projects in more developed areas would tend to be moderate because of the availability of a large local and regional workforce and the existing community infrastructure. A community impact agreement will be undertaken to deal with adverse effects.

Case 15 includes an IGCC facility. An IGCC project could require about twice as many person-years of employment as a CTU, resulting in the potential for moderate community impacts depending on where it is located. A community impact agreement would be undertaken to manage effects.

Societal Considerations

Social Acceptance

The social acceptance of Case 15 will be influenced by its nuclear component. However, the mix of technologies in this Case may enhance its social acceptability. IGCC facilities are likely to be favourably received as a fossil alternative because of the reduction in emissions.

Special/Sensitive Groups

The development of nuclear facilities in Case 15 will be of concern to environmental and nuclear energy interests. Again, key issues will be nuclear safety and the management of nuclear waste.

Development in the North would require special attention to the interests of Native and other northern residents, particularly with respect to local employment and regional economic development.

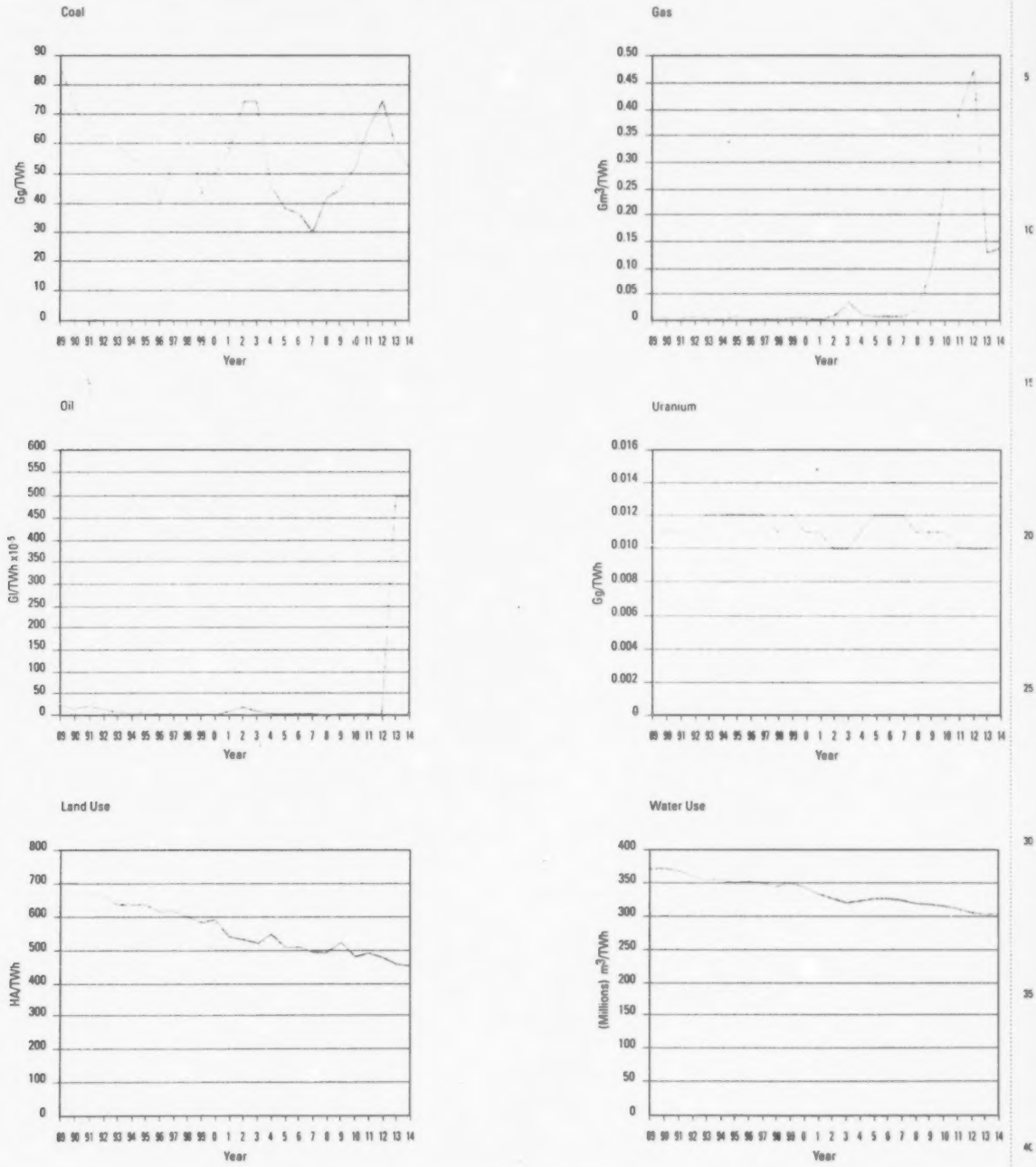
Fossil components of Case 15 may be of concern to environmental and recreational interests and resource industries potentially affected by acid and greenhouse gases and ozone levels. An IGCC facility will likely be more acceptable than a conventional steam cycle facility in this regard.

Lifestyle Impacts

Implementation of Case 15 will not likely result in significant changes in lifestyle for the majority of Ontarians. However, those in the vicinity of nuclear facilities and those particularly concerned about nuclear safety may experience a change in their daily lives or perception of their community because of their perception of risk.

The lifestyle of residents in smaller, more remote communities is likely to change. These changes will result from the influx of new residents, changing employment patterns (ie. construction employment vs. traditional occupations), increased availability of goods and services, and changing municipal services. These changes can be positive or negative and will be particularly significant for Native people with a traditional way of life.

Figure 5–14 **Case 24–Resource Use Indices–Median Load Forecast**



Development of an IGCC facility may result in modest changes to the lifestyle of surrounding residents.

Distribution of Risks and Benefits

As with other Cases, Case 15 may give rise to concerns about the equity of the exposure of communities or groups to nuclear risks. Those who perceive that they are exposed to risks at any stage of the fuel cycle or from transportation, but who do not receive a compensating benefit, may consider the situation inequitable. Concerns about the sharing of risks and benefits among current and future generations may be raised in relation to the long-term management of nuclear waste and in relation to reduction in the reserves of fossil resources and the long-term effects of greenhouse gases.

5.2.4 Case 24

5.2.4.1 Natural Environmental Impacts

Resource Use

This Case has the second highest use of coal, oil and gas resources among the Cases (Figure 5–1). Uranium use is second lowest. Normalized coal use fluctuates over time (Figure 5–14) but is slightly lower in 2014 than it was at the start of the planning period. Normalized oil and gas use increase significantly in the latter part of the planning period.

Life cycle land requirements (Figure 5–3) for this Case are higher, compared to all other Cases except Case 26. Normalized land requirements vary throughout the planning period, responding mainly to additions of new sites and associated transmission, but do not change markedly by 2014.

Life cycle water use is less than for all Cases except Case 26 and declines over the planning period (Figure 5–14).

Emissions/Effluents/Wastes

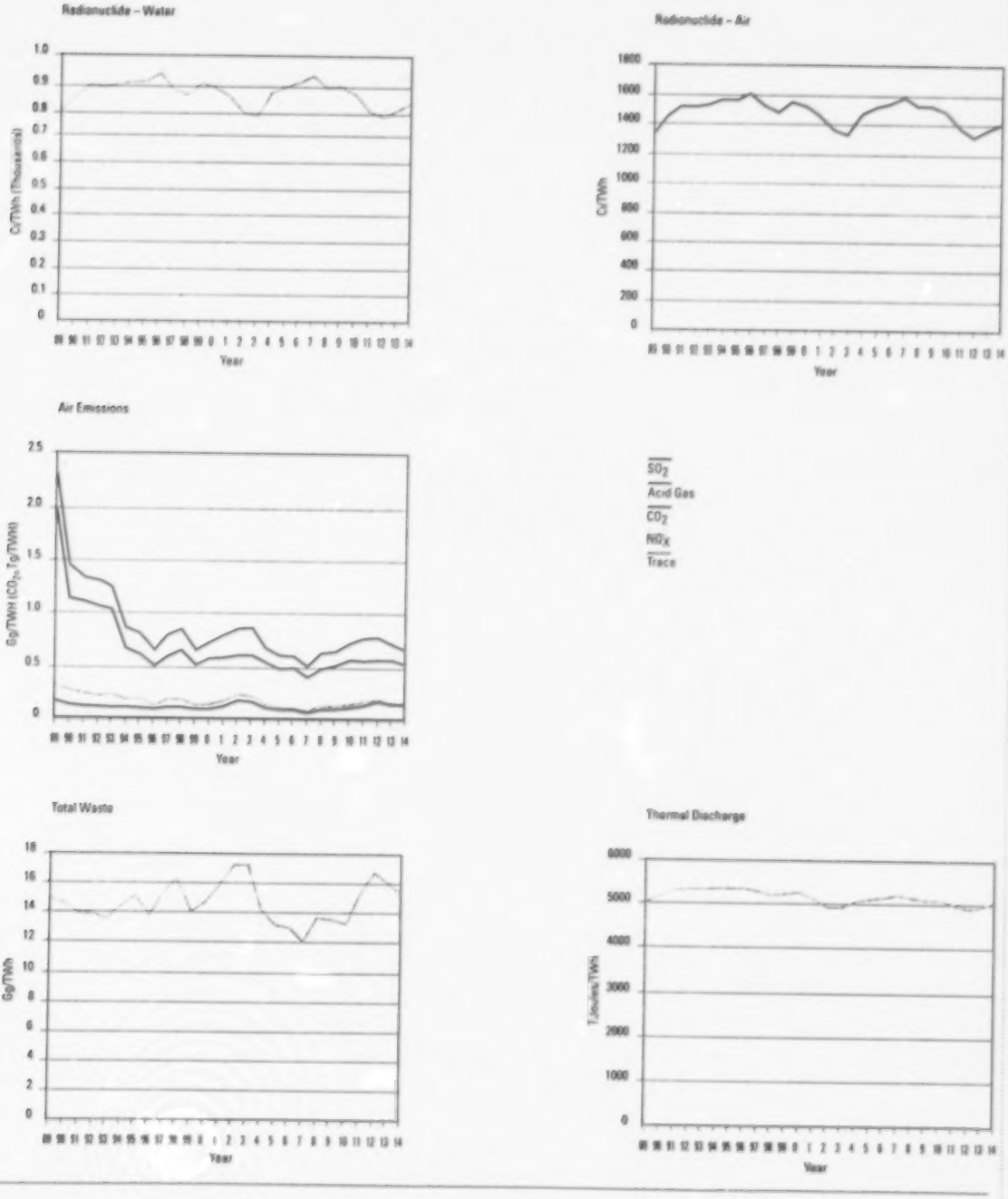
Emissions/effluents and waste production levels for Case 24 are higher than those experienced in all other Cases except Case 26. Except under the lower load forecast, CO_2 emissions for this Case cannot meet a 20% reduction, if required by 2005 (Figure 5–5). Normalized acid gas emissions (Figure 5–15) decline over time. However CO_2 emissions increase slightly over the planning period.

Life cycle waste production (Figure 5–7) is significantly higher than in all Cases except Case 26. The increased reliance on coal-fired generation significantly inflates the amount of ash/FGD wastes produced. Normalized waste production increases slightly over the planning period (Figure 5–15).

Aquatic effluents (Figure 5–6) related to generation for Case 24 are marginally lower than for all Cases except Case 26. Uranium mining and coal mining effluents for this Case are lower and higher, respectively, than in all Cases except Case 26. Normalized effluent levels decline only slightly over the study period (Figure 5–5).

Radionuclide emissions/effluents (Figures 5–4 and 5–6) are lower [9-23%] than in the Cases with additional nuclear generation, but slightly higher [4%] than in Case 26. Normalized values do not change significantly over the planning period, Figure 5–15.

Figure 5–15 **Case 24 – Emission/Effluent/Waste Indices–Median Load Forecast**



5.2.4.2 Social Environmental Impacts

Socio-Economic Effects

Regional Employment

Case 24 will provide a higher level of employment than Case 26, which has a greater emphasis on fossil generation. However, it will result in less employment than that for the other Cases previously discussed. A conventional coal facility creates more employment in construction and operation than CTU/CC/IGCC facilities of comparable size and will therefore create a significant employment benefit. Location of generation facilities in less developed areas of the province would likely result in more indirect employment, both project-related and in retail and service business.

Regional Economic Development

As with other Cases, the major regional development opportunities will occur in less developed areas of the province where special initiatives will be required to realize the regional development benefit.

A conventional coal facility offers a somewhat greater regional development opportunity than a comparable CTU/CC/IGCC facility because of its larger scale, longer construction schedule and higher employment requirements. While a conventional coal facility could provide a significant boost to the regional economy, the phased construction of the IGCC facilities may sustain the regional development opportunity over a longer period.

Local Community Impacts

The main potential for community impacts will occur as a result of the influx of project and other workers, which will in turn require expansion of municipal services and facilities. A comprehensive community impact management program, supported by a community impact agreement, will be undertaken to mitigate these effects.

Case 24 includes an IGCC facility. Even allowing for the workers required for coal and waste handling facilities, an IGCC project would have more moderate community effects than a CSC. A community impact agreement would be undertaken.

Societal Considerations

Social Acceptance

Because of its nuclear component, the social acceptance of this Case will be influenced by perceptions of risk. Issues such as safety and waste management will affect social acceptability.

The social acceptance of this Case will also be influenced by the public's perception of conventional coal generation, particularly their perception of acid gas and greenhouse effects. The IGCC component may be perceived as cleaner and therefore may be more socially acceptable.

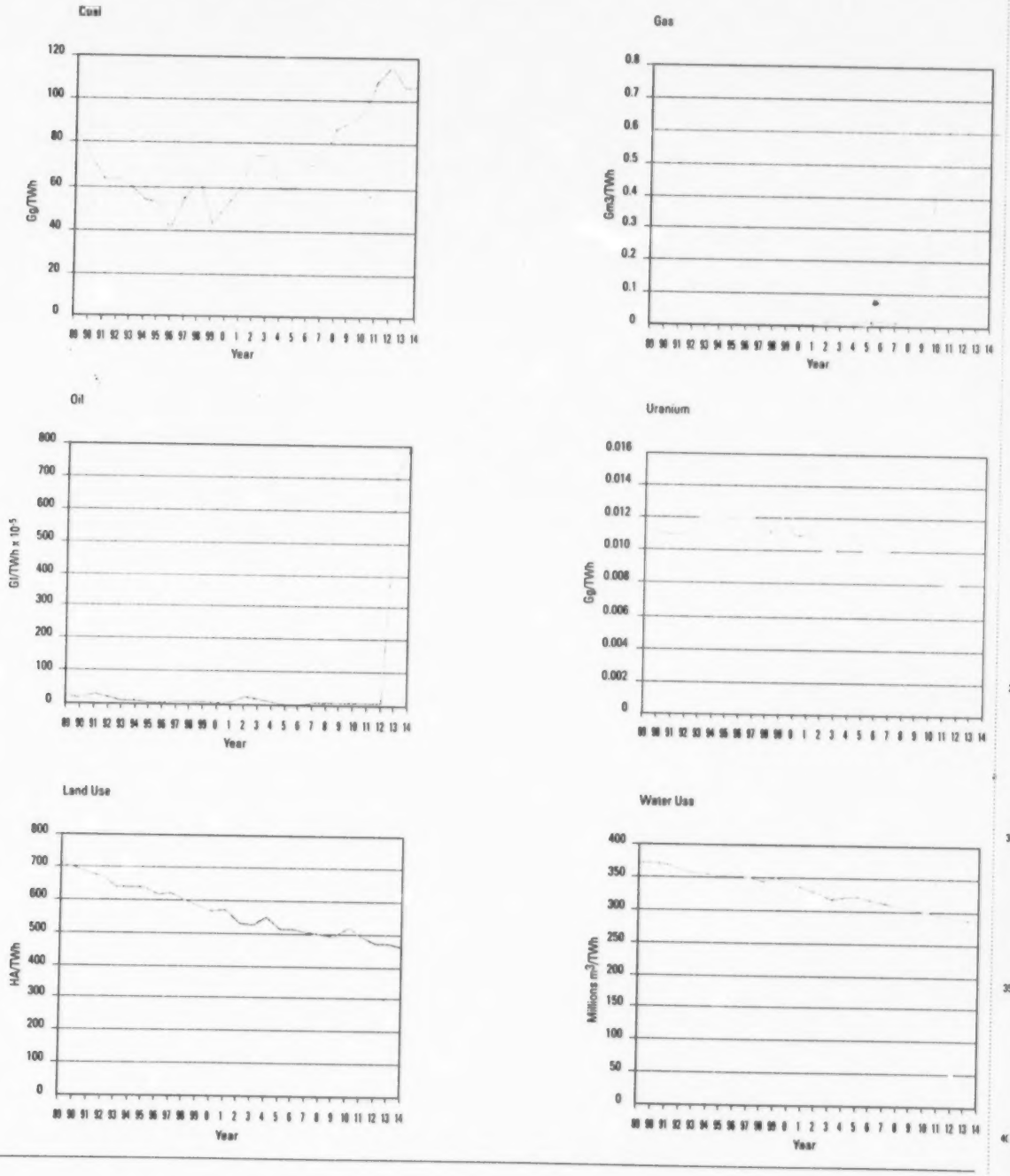
Special/Sensitive Groups

The inclusion of nuclear facilities in Case 24 will be of concern to environmental and nuclear energy interests. Again, key issues will be safety and the management of nuclear waste.

Development in the north would require special attention to the interests of Native and other northern residents, particularly with respect to local employment and regional economic development.

Fossil components of Case 24 will be of concern to environmental and recreational interests and to resource industries potentially affected by acid rain, greenhouse gases and ozone levels.

Figure 5–16 **Case 26 – Resource Use Indices–Median Load Forecast**



Lifestyle Impacts

Implementation of Case 24 will not likely result in significant changes in lifestyle for the majority of Ontarians. However, those in the vicinity of nuclear facilities and those particularly concerned about nuclear safety may experience a change in their daily lives or in the perception of their community because of their perception of risk.

The lifestyle of residents in less developed communities could be changed as a result of the in-migration of new residents, changing employment patterns, increased availability of goods and services, and changing municipal services. These changes can be positive or negative and will be particularly significant for Native people with a traditional way of life.

Distribution of Risks and Benefits

As with other Cases, Case 24 may give rise to concerns about the equity of the exposure of communities or groups to nuclear risks. Those who perceive that they are exposed to risks at any stage of the fuel cycle or from transportation, but who do not receive a compensating benefit, may consider the situation inequitable. Concerns about the sharing of risks and benefits among current and future generations may be raised in relation to the long-term management of nuclear waste, and in relation to reductions in the reserves of fossil resources and the long-term effects of greenhouse gases.

5.2.5 Case 26

5.2.5.1 Natural Environmental Impacts

Resource Use

The fossil fuel dominance in this Case contributes to it having the highest level of non-renewable resource use (Figure 5–1). Coal use increases steadily over the planning period (Figure 5–16), while oil and gas use increase drastically in the latter part of the planning period. Uranium use is lowest among Cases and normalized use declines over the planning period (Figure 5–16).

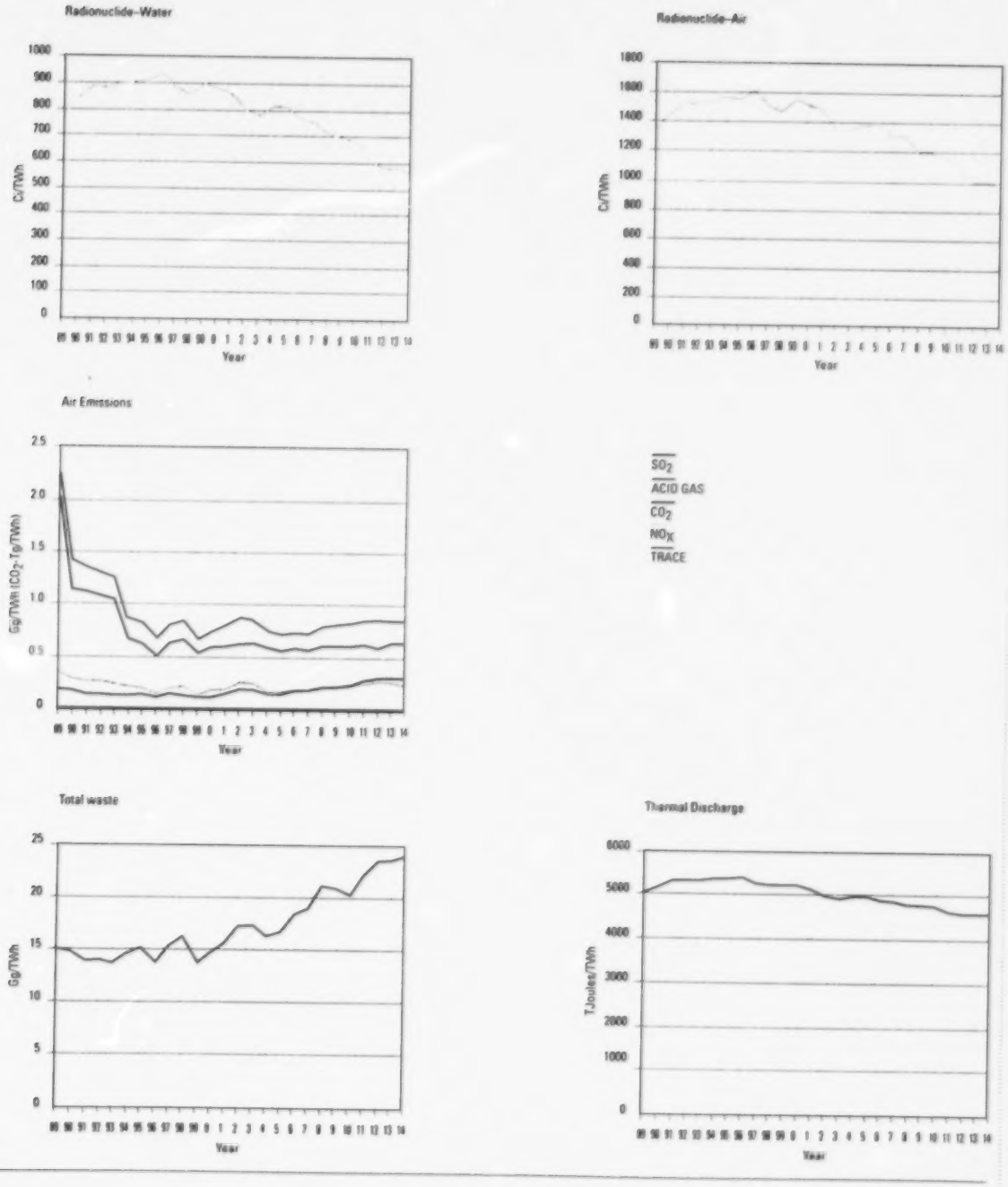
Life cycle land use requirements (Figure 5–3) are highest of all Cases, mainly due to higher comparative land requirements related to mining and waste disposal activities. As with all other Cases, normalized land use varies significantly over time in response to site and transmission additions. However, land use requirements decrease by the end of the planning period (Figure 5–16).

Life cycle water use is lowest for Case 26, reflecting the lower cooling water requirements of fossil generation, versus nuclear generation, and lower uranium mining activity. Normalized water use values decrease over the course of the planning period (Figure 5–16).

Emissions/Effluents/Wastes

Heaviest reliance on fossil-based generation results in acid gas emissions for Case 26 being higher than for the other Cases (Figure 5–5). Normalized acid gas emissions decline until about 2000 and then remain stable to the end of the planning period (Figure 5–17). CO_2 emissions (Figure 5–5) are highest for this

Figure 5–17 **Case 26 – Emission/Effluent/Waste Indices–Median Load Forecast**



Case. A proposed 20% reduction in CO_2 emission levels in 2005 cannot be met by this Case under any of the load forecasts. Normalized CO_2 emissions increase slightly over the planning period (Figure 5–17).

Aquatic effluents from generation are the lowest among the alternative Cases (Figure 5–6), while uranium and coal mining effluents are lowest and highest respectively among Cases. Normalized effluents decline slightly over the study period, (Figure 5–17).

Radionuclide emissions/effluents/wastes (Figures 5–4, 5–6 and 5–7) are lowest for this Case, due to the reduced use of nuclear generation. Normalized values decline over the planning period (Figure 5–17).

Waste production levels (Figure 5–7) are highest for Case 26. Normalized waste production increases over the planning period (Figure 5–17).

5.2.5.2 Social Environmental Impacts

Socio Economic Effects

Regional Employment

Case 26 is likely to create the least construction employment of the alternative Cases. IGCC plants create about one third less employment than nuclear plants of equivalent size. The employment created by conventional coal facilities will be important particularly in areas where there are higher levels of unemployment. The level of local employment will depend on special initiatives for local hiring and training. In some areas of the province, even with local initiatives, there will likely be a need for in-migration of project workers. Location of facilities in less developed areas would likely result in more indirect employment, in both project-related and retail and service businesses.

The development of a CTU/CC facility will create relatively few jobs. CTUs can be served by local and commuting workers and are not likely to result in significant indirect employment.

Regional Economic Development

As with other Cases, the major regional development opportunities will occur in less developed areas of the province, where special initiatives will be required to realize the regional development benefit. Case 26 provides opportunities for regional development with two conventional coal facilities in addition to an IGCC facility.

A conventional coal facility offers somewhat greater regional development opportunity than a comparable CTU/CC/IGCC facility because of its larger scale, longer construction schedule and higher employment requirements. While a conventional coal facility could provide a significant boost to the regional economy, the phased construction of IGCC facilities may sustain the regional development opportunity over a longer period.

Local Community Impacts

The influx of project and other workers with the development of a fossil station may require expansion of municipal services and facilities in some communities. A comprehensive community impact management program, with a community impact agreement, will be undertaken to mitigate these effects. Relative to CSC facilities, fewer community impacts will occur with an IGCC in an area where there is access to a local and commuting workforce. However, a community impact management program may be needed to mitigate some of these effects.

Figure 5–18 **Atmospheric Emissions–Median Load Forecast**

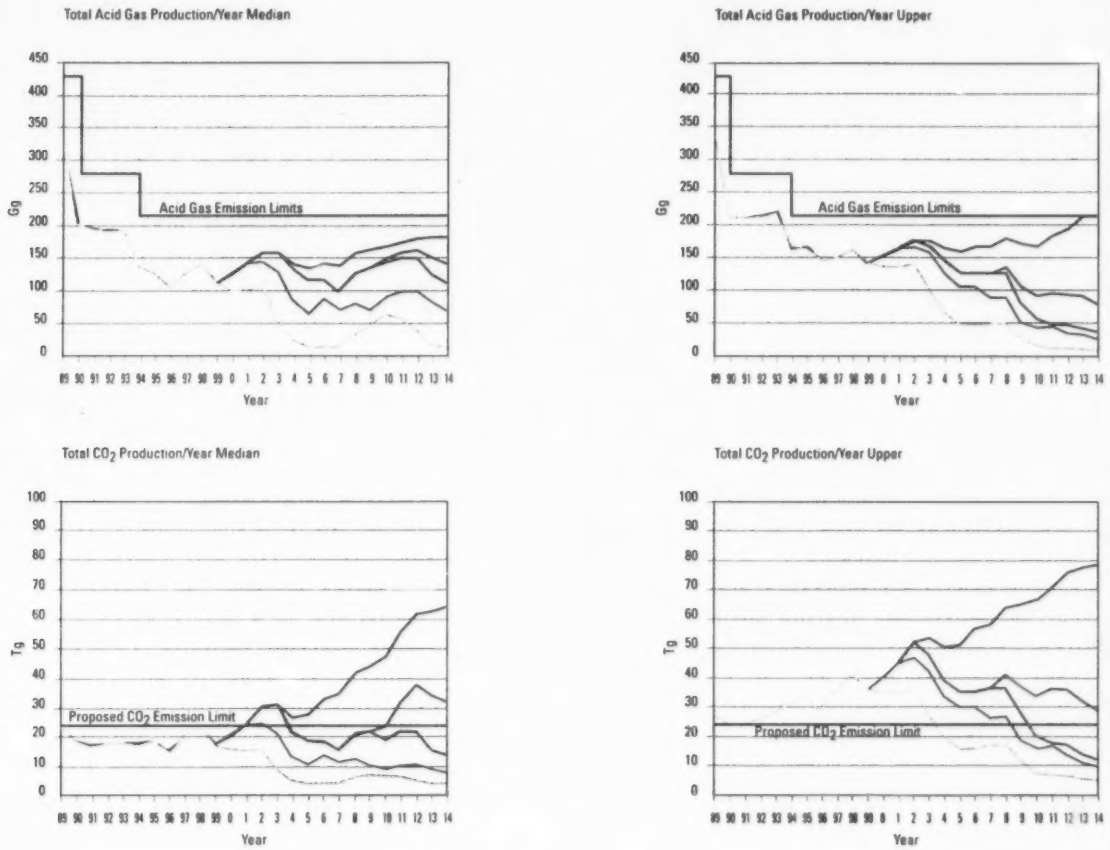


Figure 5–18 **Atmospheric Emissions–Median Load Forecast**

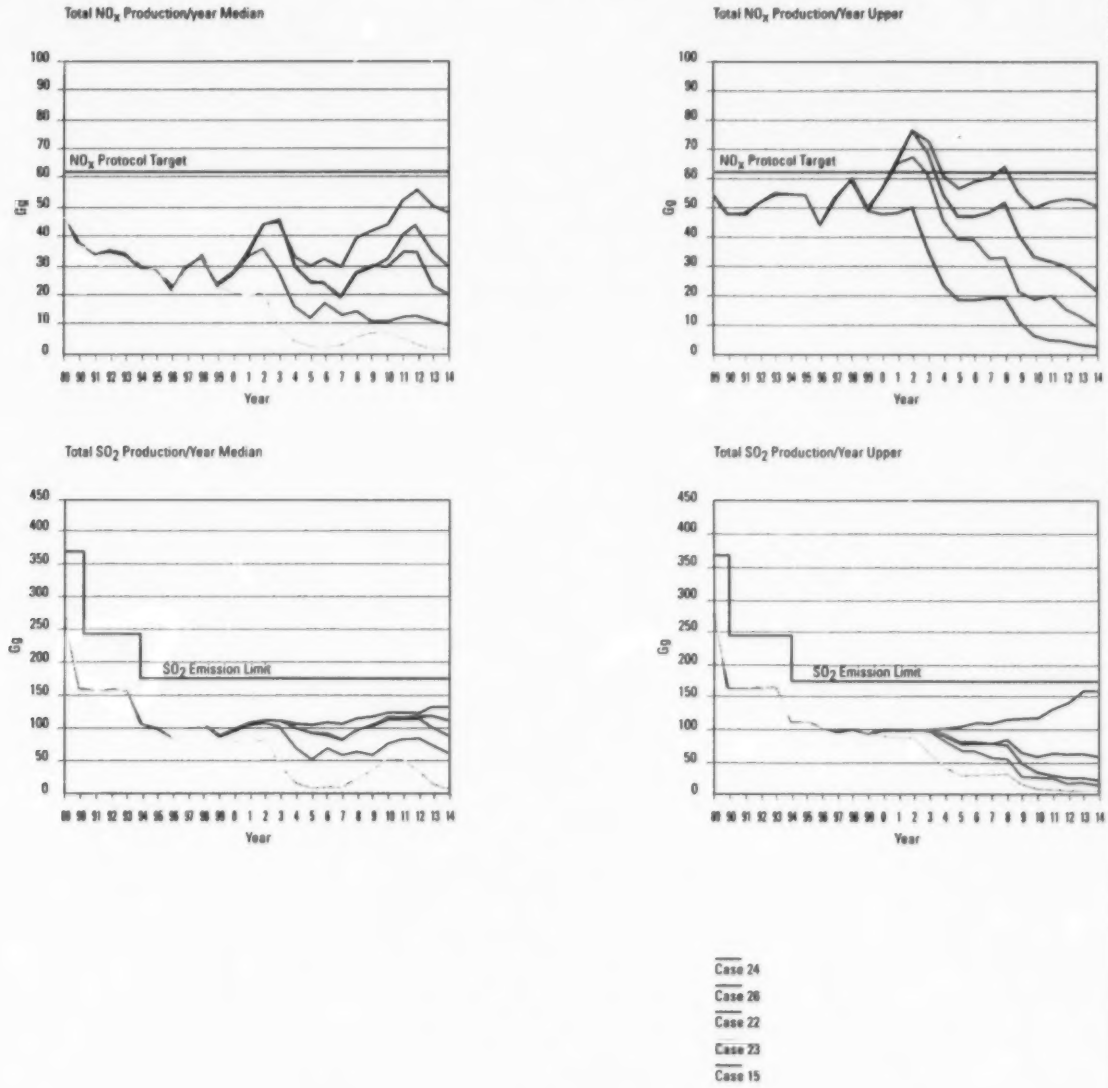


Table 5.3 Siting Requirements for Load Growth Cases

	Number of Illustrative Sites Used				
Load Forecast	**Case 23**	**Case 22**	**Case 15**	**Case 24**	**Case 26**
Existing Sites Used:					
Lower	2	2	4	4	4
Median	1	4	5	5	5
Upper	4	7	8	8	8
New Sites Used:					
Lower	2	1	1	1	1
Median	3	2	2	2	2
Upper	4	3	3	3	3
Total Sites Used:					
Lower	4	3	5	5	5
Median	4	6	7	7	7
Upper	8	10	11	11	11

Societal Considerations

Social Acceptance

The social acceptance of Case 26 will be influenced by public perception of the risks associated with the use of fossil technologies and the appropriateness of using finite fossil resources for energy production. The use of scrubbers and IGCC technology may raise social acceptability, but this could be offset by greenhouse concerns.

Special/Sensitive Groups

The exclusive reliance on fossil fuels for new supply in Case 26 will be of concern to environmental and recreational interests, and resource industries potentially affected by acid rain, greenhouse gases and ozone levels. The increased reliance on gas or oil for CTUs, particularly if they are not converted to CC and IGCC, will be an issue for environmental, conservation, and energy interests who object to the use of gas and oil for electricity generation.

Development of a conventional coal facility in a northern area of the province will be of concern because of the potential impacts on Native and other northern residents. Local employment and regional development will be of particular concern.

Lifestyle Impacts

The main lifestyle impact of Case 26 will occur in less developed areas of the province, with the influx of new residents, changing employment, increased availability of goods and services, and changing municipal services. These changes can be positive or negative, and will be particularly significant for Native people with a traditional way of life.

Distribution of Risks and Benefits

Common to all Cases, Case 26 may raise equity concerns among those who have the risks of the facility, but who do not receive any compensating benefit. Concerns about the sharing of risk and benefits among current and future generations may be raised in relation to reductions in the reserves of fossil resources, and the long-term effects of acid gas and greenhouse gases.

5.3 Sensitivity Considerations

Changes in a number of conditions or assumptions used in this analysis could significantly affect the environmental effects of the alternative Cases. These include changes in load growth, assumed planning period, assumptions related to facility siting and potential future regulatory changes. Following is a discussion of each of these considerations.

5.3.1 Load Growth

A change in load growth will affect the timing, type, and amount of generation increments and number of sites for each Case (Table 5–3).

Higher load growth would require that more generation be developed in a shorter time period. Since certain supply options have long approval and construction lead times, the variety of options available to meet an upper load forecast situation may be significantly reduced, particularly in the mid to late 1990s. The earliest a new major supply facility can be in-service is about 2001. As a result, significantly greater quantities of shorter lead-time fossil-based generation will have to be utilized. Developing more generation, more quickly will also have implications on resource use, emissions/effluents, waste production and socio-economic conditions. To deal with upper load, most Cases include significant quantities of CTUs at existing sites. As shown in Table 5.4, this will result in significant increases in fossil fuel use, particularly coal. There will also be noticeable increases in limestone consumed and waste quantities produced, as a result of increased use of FGD facilities to keep emissions below specified acid gas emission limits. Heavier reliance on CTUs in the upper load forecast produces a corresponding increase in atmospheric emissions of SO_2, NOx and CO_2. Under upper load growth, all Cases could have difficulty meeting proposed limits for NOx and CO_2 (Figure 5.18). Future regulations for water effluents, waste production or land use, are heading toward a zero discharge or maximum re-use philosophy. Compliance under upper load growth would be much more difficult and costly.

Low load growth would delay and reduce effects anticipated under the median load forecast.

5.3.2 Planning Period

Since a significant proportion of new generation is added in all Cases in the period after 2000, the timeframe for the analysis (to 2014) may understate the differences in environmental performance among the Cases. The effect of generation added in the post 2010 period, for example, will hardly be realized by the time the assumed planning period ends in 2014.

To determine how plan performance might change over a longer planning period, projections have been made for an additional 25-year period to 2039. The projections assume median load growth, and constant annual energy production, based on average energy production over the period 2010 to 2014. The projections do not include new demand/supply options required to meet any additional post-2014 needs.

Table 5–4 **Changes in Natural Environment Values: Median to Upper Load**

			Case*		
Factor / Criterion	**23**	**22**	**15**	**24**	**26**
A. Resource Use					
Non-Renewables: Fuel					
1. Coal	1.87	1.71	1.42	1.42	1.45
2. Oil	2.67	1.90	1.12	1.04	1.23
3. Gas	224.00	21.00	4.00	3.43	3.15
4. Uranium	1.09	1.05	1.08	1.04	1.02
Non-Renewables: Other					
1. Limestone (for FGD)	3.50	3.39	3.19	2.82	2.30
Water Use					
1. Water (Generation Related)	1.11	1.10	1.11	1.11	1.08
2. Water (Life Cycle)	1.09	1.07	1.07	1.07	1.03
Land Use					
1. Land (Generation Related)	1.08	1.16	1.16	1.15	1.16
2. Land (Life Cycle)	1.17	1.22	1.19	1.18	1.24
B.Emissions / Effluent / Wastes					
Atmospheric Emissions					
1. SO_2	1.00	0.92	0.83	0.87	1.03
2. NO_x	1.80	1.83	1.50	1.62	1.40
3. Total Acid Gas (SO_2 + NO_x)	1.20	1.09	0.97	1.02	1.14
4. CO_2	1.85	1.78	1.55	1.54	1.52
5. Radionuclides	1.07	1.06	1.07	1.06	1.03
6. Trace Elements	2.00	1.87	1.60	1.57	1.56
Aquatic Effluents					
1. Thermal Discharge	1.13	1.12	1.14	1.12	1.11
2. Radionuclides	1.07	1.07	1.07	1.08	1.00
3. Uranium Mining Effluent	1.07	1.05	1.08	1.07	1.00
4. Coal Mining Effluent	1.60	1.28	1.25	1.67	1.23
Wastes					
1. Coal Ash	1.78	1.61	1.29	1.29	1.31
2. FGD Wastes	3.60	3.45	3.23	2.82	2.30
3. Used Nuclear Fuel	1.07	1.06	0.98	1.06	1.01
4. Low Level Radioactive Waste	1.07	1.06	0.98	1.06	1.01
5. Uranium Mine Tailings	1.07	1.05	1.08	1.06	1.01

**Note: Assumes Median Load Values = 1.00*

The performance of nuclear-based plans improves significantly with respect to non-renewable (fossil fuel and limestone) resource use, land use (related to mining and wastes), acid gas and CO_2 emissions and conventional waste production. Performance declines with respect to cooling water use, radionuclide emission/effluent, uranium use/mining and radioactive waste production.

The performance of fossil-based plans improves with respect to cooling water use, uranium mining/use and radioactive waste production. Case performance declines noticeably in terms of non-renewable fuel (fossil fuel and limestone) use, land use (related to mining and wastes), CO_2 emissions and ash/FGD waste production. Slight increases occur in acid gas emissions. However, with controls assumed, these remain within prevailing emission limits.

Case 15 exhibits characteristics of both nuclear and fossil based plans, but at more moderate levels.

5.3.3 Siting

Siting will determine the precise nature and magnitude of natural and social environmental effects associated with the development and operation of generating facilities. Prudent siting can minimize problems, such as major land use conflicts, poor waterbody conditions, and airshed use conflicts. Siting will also determine the nature and extent of transmission incorporation requirements and related concerns. Site-specific concerns will be evaluated in detail during project EA studies.

As noted in Section 2.3, a number of illustrative sites (Table 2.7) have been identified and incorporated in each Case to demonstrate that technically feasible sites exist for the range of supply options being proposed; to provide a basis for carrying out the environmental review and to complete cost estimates. This site context is particularly relevant when discussing the social implications of alternative Cases, especially regional development and local community aspects.

Natural and social environmental implications of the illustrative sites used in the plan analysis are discussed more fully below.

Natural Environment

From a natural environment viewpoint, it is not so critical when sites are developed, but how many – that is, what land will be required and what transmission incorporation will be needed.

Although siting differences among Cases are not significant, certain characteristics of the reference sites could have natural environment implications. While these would be more thoroughly dealt with in any project EAs for proposed facilities (developed subsequent to this DSP review), highlighting potential concerns is useful.

Social Environment

To adequately understand and address the social environmental impacts of individual projects, specific sites will have to be determined.

Differences in socio-economic effects and societal considerations depend on the characteristics of a particular site and its environs. The presence of an appropriately skilled labour force, the adequacy of the municipal infrastructure, and the number and range of community facilities and services will largely determine the magnitude and significance of the effects of the project.

A summary of social and natural environmental considerations at candidate sites is provided in Table 5–6.

Table 5-5 Comparison of Cumulative Effects at 2014 and 2039: Natural Environment
(Median Load)

Criterion	Case 23		22		15		24		26		
A. Resource Use	2014	2039	2014	2039	2014	2039	2014	2039	2014	2039	Units
Non-Renewables: Fuel											
1. Coal	131.0	22.0	176.0	72.0	228.0	182.0	255.0	318.0	341.0	555.0	Tg
2. Oil	0.3	0.5	0.8	2.5	1.7	7.5	2.4	10.0	3.5	15.0	Gl
3. Gas	0.0	0.0	30.0	148.0	252.0	1082.0	327.0	1450.0	519.0	2318.0	Gm^3
4. Uranium	57.0	70.0	55.0	68.0	53.0	65.0	51.0	55.0	46.0	40.0	Gg
Non-Renewables: Other											
1. Limestone (for FGD)	2.6	0.0	3.6	0.0	4.2	0.0	5.7	7.5	10.8	22.5	Tg
Water Use											
1. Water (Generation Related)	567.0	670.0	555.0	655.0	541.0	625.0	530.0	580.0	504.0	500.0	Gm^3
2. Water (Life Cycle)	1.57	1.7	1.55	1.68	1.54	1.65	1.51	1.6	1.50	1.52	Tm^3
Land Use											
1.Land (Generation Related)	17.2	4.2	15.3	3.0	15.4	14.1	15.5	24.2	15.8	43.1	$Ha10^3$
2.Land (Life Cycle)	59.0	0.02	60.0	0.02	63.0	0.30	66.0	0.70	72.0	1.4	$Ha10^3$
B. Emissions / Effluents / Wastes											
Atmospheric Emissions											
1. SO_2	2.0	0.8	2.6	1.9	3.0	2.6	3.1	2.9	3.2	3.2	Tg
2. NO_X	0.5	0.1	0.6	0.3	0.8	0.7	0.8	0.9	1.0	1.2	Tg
3. Total Acid Gas (SO_2+ NO_x)	2.5	0.9	3.2	2.2	3.8	3.6	3.9	3.8	4.2	4.4	Tg
4. CO_2	325.0	130.0	419.0	238.0	523.0	455.0	590.0	792.0	815.0	1455.0	Tg
5. Radionuclides	7.5	9.8	7.2	8.8	6.9	8.0	6.8	7.0	6.0	5.0	$Ci•10^6$
6. Trace Elements	17.0	3.0	23.0	10.0	30.0	25.0	34.0	46.0	48.0	85.0	Gg
Aquatic Effluents											
1. Thermal Discharge	24.7	8.0	24.3	7.8	24.0	7.5	23.7	7.2	23.0	6.8	$Tj•10^3$
2. Radionuclides	4.4	5.5	4.2	5.2	4.1	4.8	4.0	4.2	3.6	3.0	$Ci10^6$
3. Uranium Mining Effluent	8.4	10.2	8.1	10.0	7.7	9.0	7.5	8.0	6.8	6.0	Tg
4. Coal Mining Effluent	0.5	0.1	0.7	0.3	0.8	0.6	0.9	1.2	1.3	2.2	Tg
Wastes											
1. Coal Ash	12.5	1.9	16.8	7.0	22.4	19.8	24.7	31.5	31.8	50.3	Tg
2. FGD Wastes	4.8	0.0	6.7	0.0	7.9	0.0	10.8	14.2	20.6	42.2	Tg
3. Used Nuclear Fuel	57.5	70.0	55.3	67.5	52.9	62.5	51.4	55.0	46.6	40.0	Gg
4. Low Level Radioactive Waste	23.0	27.5	22.1	27.5	21.2	25.0	20.6	22.5	18.6	17.5	Gg
5. Uranium Mine Tailings	36.2	44.2	34.9	42.8	33.3	39.2	32.4	34.8	29.3	25.8	Tg
6. Total Wastes	53.7	47.5	58.4	50.0	63.7	60.0	67.9	47.5	81.8	117.5	Tg

Table 5.6 Candidate Sites – Summary of Potential Considerations

Sites	Generation Type	Natural	Social
Darlington	– Nuclear	– proposed dock at Canada Cement – plume dispersion implications	– readily available workforce – existing community concerns (equity, health, emergency planning)
N. Channel	– Nuclear – Fossil (CSC/IGCC)	– cooling water constraints – LaCloche Mtns. area – transmission incorporation	– recreational interests (LaCloche Mtns., Manitoulin Is.) – expressed interest in hosting new GS. – site not owned by Hydro – direct and indirect employment opportunities
Wesleyville	– Fossil (CSC/IGCC) – Nuclear	– exclusion zone concerns – on-site and adjacent terrestrial concerns (Eastern and Central marshes) – coal delivery dock required – ash/FGD waste disposal (space concerns)	– possible local concerns re: equity, health, emergency planning, increased traffic – employment potential
Lakeview	– Fossil (CTU/CC/IGCC*)	– waste disposal – local air quality concerns – fugitive dust emissions	– conflict with waterfront development objectives of Mississauga / Metro – perception problems (acceptance) – adjacent marina / parkland
Lambton	– Fossil (CTU/CC/IGCC*)	– ash/FGD waste disposal – fugitive dust emissions	– regional economic stimulus – employment stimulus – increased traffic (St. Clair Parkway) – possible Native issues
Lennox	– Fossil (CTU/CC/IGCC*)	– cooling water concerns – on-site wetland – coal storage	– proximiy to heritage highway – economic stimulus – possible local concerns re: equity
Nanticoke	– Fossil (CTU/CC)	– cooling water concerns (Long Point Bay)	– limited economic stimulus – possible local concerns (cottagers)
Hearn	– Fossil (CTU/CC)	– outdoor storage of coal on–site – cooling water concerns (Toronto Harbour infilling)	– conflict with recreational development objectives of Metro waterfront
Keith	– Fossil (CTU/CC)	– air quality concerns – cooling water concerns	– limited economic stimulus – land-use conflicts – specialty crop agriculture
Bruce	– Nuclear	– potential for cumulative impacts on wildlife habitat – potential impact on recreational lands	– equity concerns – employment potential

* IGCC after retirement of existing CSC Coal plant post-year 2000

Table 5-7 **Potential Regulatory Changes Affecting Demand/Supply Planning in the Period 1989-2014**

Air Emissions

1. CO_2 reductions
2. NO_x Prtocol – freeze at 1987 levels
3. Regulation 308 Revision – emission limits/BACTEA
4. Radionuclide dose limit reduction (ICRP)
5. CFC Ban by 1992
6. Indoor air quality standards tightened

Aquatic Effluents

1. MISA limits and BACTEA (zero discharge)
2. Mercury in reservoirs – tighter control
3. Radionuclide dose limit reduction (ICRP)
4. Water use charges for cooling water use

Wastes

1. PCB phase-out by 1993
2. Waste reduction targets (25% by 1992; 50% by 2000

Legend *CFC Chlorofluorocarbons*
MISA Municipal Industrial Strategy for Abatement
BACTEA Best Available Control Technology Economically Achievable
PCB Polychlorinated Bi-Phenyls

5.3.4 Regulatory Changes

Table 5.7 summarizes a number of regulatory initiatives that are likely to occur over the assumed study period. In general, regulations are likely to become tighter and to stress control at source, and reduced emissions/effluents/waste production. More emphasis will be placed on integrated environmental management, whereby waste (i.e., steam, water, solid wastes) recycling and re-use will be encouraged. Increased concern for large-scale, global issues (e.g., greenhouse effect, ozone) is anticipated.

A recent international NOx protocol, signed by Canada, calls for a freeze of NOx emissions at 1987 levels. However, lower limits are being discussed. Figure 5–18 indicates all Cases can meet a 60 Gg/a limit. With upper load growth, the 60 Gg/a limit could be difficult to meet for all Cases.

Federal and provincial energy ministers have recommended that CO_2 emissions be reduced by 20% by 2005. A further reduction to 50% by 2020 has also been discussed. The implications of achieving the 20% reduction target are being examined by both a federal-provincial task force and by Ontario Hydro. Figure 5–18 illustrates the ability of the Cases to meet the 20% reduction target. Under median load growth, only Cases 24 and 26 have problems meeting the proposed 20% target. A 50% reduction target could be met only by Case 23.

Regulations governing point source atmospheric emissions are likely to be tightened during the planning period. Regulation 308 under the Environmental Protection Act is currently being revised and is expected to significantly reduce allowable emissions. These proposed amendments emphasize at-source control by best available control technology (BACT). The operation of existing plants could be significantly affected by this control philosophy.

The International Commission on Radiation Protection (ICRP) is contemplating a significant reduction (i.e., by up to a factor of ten) in recommended radiation standards. It is anticipated that Hydro's self-imposed stricter standards would permit even the highest nuclear Case (Case 23) to meet these significantly tightened limits.

Consumptive water use and the release of toxins to the Great Lakes are becoming issues of regulatory concern. Water use charges are being contemplated for large users in the Great Lakes basin. This could have significant financial implications for existing and proposed thermal generating stations on the Great Lakes.

The Municipal Industrial Strategy for Abatement (MISA) Program in Ontario is focussing on achieving "virtual elimination" of toxic discharges to the Great Lakes and connecting waterways. Regulations governing Ontario Hydro's waste water discharges are being developed. As with Regulation 308, these measures are stressing at-source control and application of best available control technology. Complementary federal policy is moving toward "zero discharge" for industrial users in the Great Lakes Basin. Measures to optimize use of water and reduce discharges to the aquatic environment will be an important consideration in implementing individual supply components under a preferred plan.

For all Cases, meeting a proposed provincial target calling for a 50% reduction in solid waste production by 2000 would require Hydro to recycle between 1 and 2 Tg of waste per annum. The heavier fossil-based Cases (Cases 24 and 26) would have greater difficulty achieving this target.

6.0 Summary of Analysis

This section summarizes the results of the environmental analysis. The natural and social environmental advantages and disadvantages are the focus for this discussion.

Opportunities to mitigate or compensate for potential adverse environmental effects are identified. Residual effects and programs which offer the potential to reduce these effects are described. The report then sets out nine conclusions.

6.1 Natural Environment

Table 6–1 uses emission/use values estimated in Table 5–2 to determine the relative percent differences among Cases, assuming median load. The lowest emission/use value for each criteria is assigned a base value of 1.00. A value of 2.00, for example, would indicate that a Case uses twice as much resource or produces twice as much emission/effluent/waste as the base case.

In addition, comparative indices have been developed whereby annual estimates of resource use/emissions have been normalized by re ducing them to a per TWh basis (using total TWh produced in each year). These indices (Figures 6–1 to 6–9) give a general indication of relative trends in system environmental performance over the plan period. Noticeable differences do not occur until after 2000, when significant new supply is added to the BES.

6.1.1 Resource Use

Non-Renewable Resources

Case 23 consumes marginally fewer non-renewable resources than in Case 22 and significantly less than the two fossil-based Cases (Cases 24 and 26) and the mixed Case (Case 15). All Cases, except Case 26, show a net decline in use of coal resources over the planning period (Figure 6–1). Gas and oil resource use remains negligible in all Cases until the latter part of the planning period. Use of uranium increases in all cases, except Case 26.

Use of limestone for FGD varies significantly among Cases (Figure 6–1), with the fossil-based Cases showing dramatic increases in use in the post-2000 period. This increase reflects the expanded application of FGD required to keep total acid gas emissions within current regulatory limits.

Land Use

All Cases show a decrease in the normalized requirement for land resources over the study period (Figure 6–2). From a life cycle perspective, the nuclear-based Cases displace less land than the fossil-based Cases.

Table 6-1 Plan Comparison Summary: Natural Environment — Medium Load

Factor / Criterion	Case* 23	22	15	24	26
A. Resource Use					
Non-Renewables: Fuel					
1. Coal	1.00	1.33	1.68	1.93	2.59
2. Oil	1.00	2.88	6.57	9.00	13.38
3. Gas**	1.00	30.00	252.00	326	519.00
4. Uranium	1.23	1.18	1.13	1.10	1.00
Non-Renewables: Other					
1. Limestone (for FGD)	1.00	1.39	1.63	2.22	4.24
Water Use					
1. Water (Generation Related)	1.12	1.10	1.07	1.06	1.00
2. Water (Life Cycle)	1.04	1.03	1.02	1.02	1.00
Land Use					
1. Land (Generation Related)	1.13	1.00	1.01	1.01	1.03
2. Land (Life Cycle)	1.00	1.02	1.07	1.11	1.23
B. Emissions / Effluents / Wastes					
Atmospheric Emissions					
1. SO_2	1.00	1.29	1.46	1.49	1.56
2. NO_x	1.00	1.32	1.71	1.79	2.05
3. Total Acid Gas ($SO_2 + NO_x$)	1.00	1.29	1.51	1.54	1.65
4. CO_2	1.00	1.28	1.61	1.82	2.51
5. Radionuclides	1.23	1.19	1.14	1.10	1.00
6. Trace Elements	1.00	1.34	1.73	1.91	2.75
Aquatic Effluent					
1. Thermal Discharge	1.07	1.06	1.04	1.03	1.00
2. Radionuclides	1.23	1.19	1.14	1.10	1.00
3. Uranium Mining Effluent	1.23	1.19	1.14	1.10	1.00
4. Coal Mining Effluent	1.00	1.33	1.68	1.91	2.65
Wastes					
1. Coal Ash	1.00	1.34	1.78	1.97	2.54
2. FGD Wastes	1.00	1.39	1.63	2.22	4.24
3. Used Nuclear Fuel	1.23	1.19	1.14	1.10	1.00
4. Low Level Radioactive Waste	1.23	1.19	1.14	1.10	1.00
5. Uranium Mine Tailings	1.23	1.19	1.14	1.10	1.00
6. Total Wastes	1.00	1.09	1.19	1.27	1.52

Note *1.00 = Lowest Value (base case) among cases/plans
Other Values represent % difference from Lowest (base) Value
**Case 23 assumes no gas is used — therefore, Case 22 should be assumed base value

Figure 6–1 **Non-Renewable Resource Use Index – All Cases**

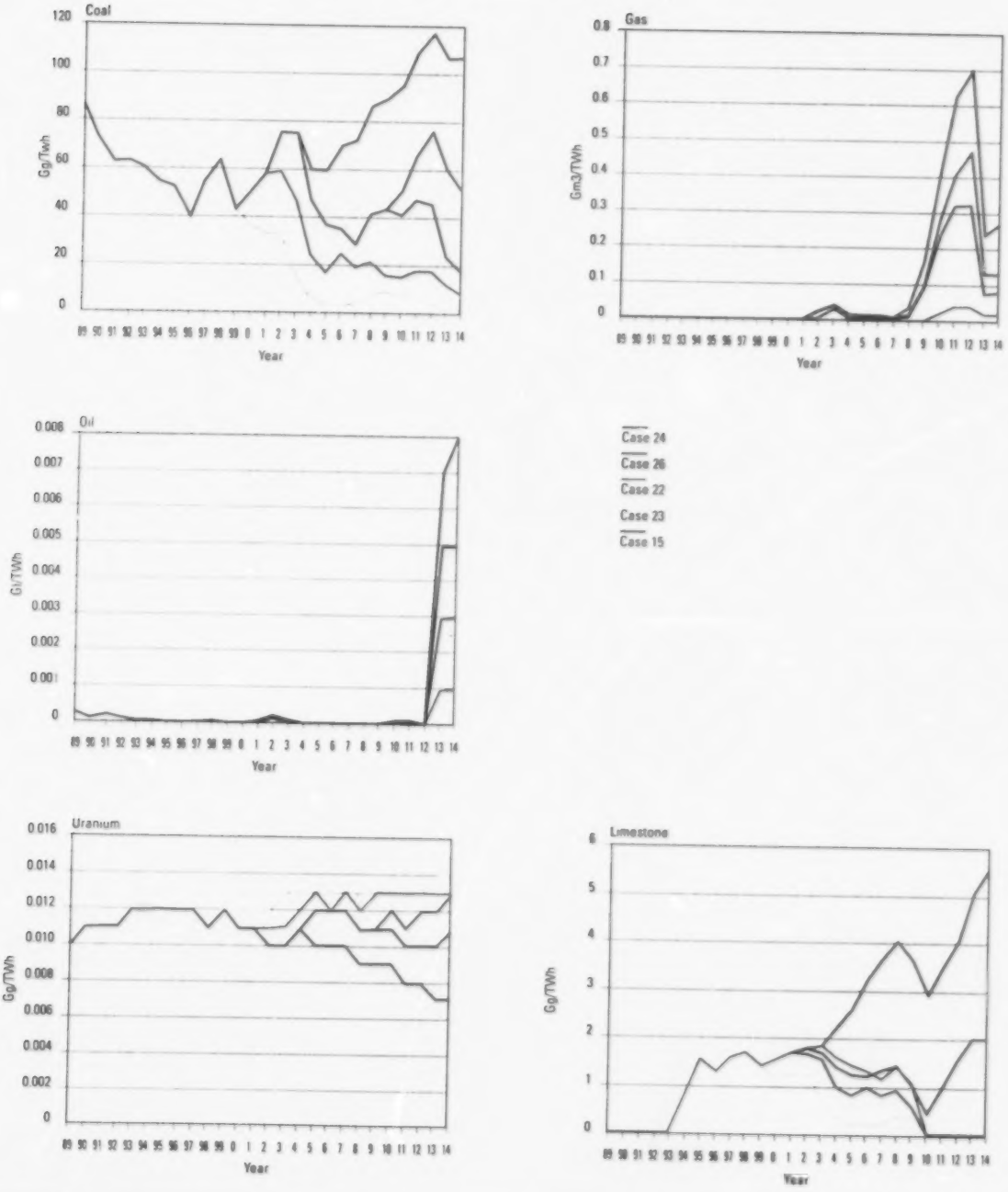


Figure 6-2 **Land Use Index – All Cases**

Note: Includes all Ontario Hydro-owned land prior to 1989.

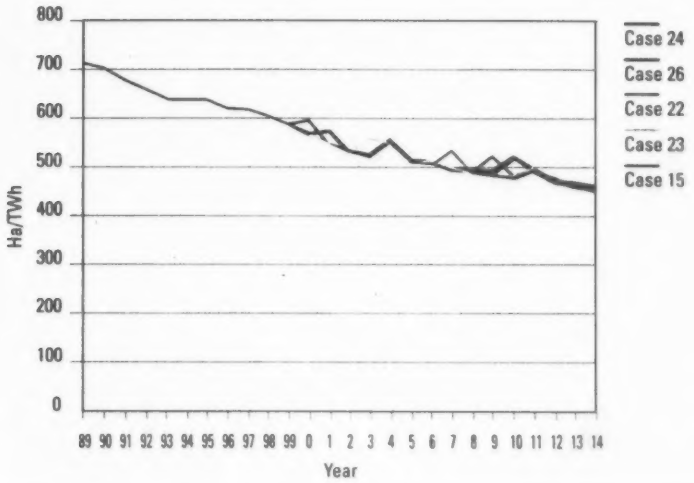
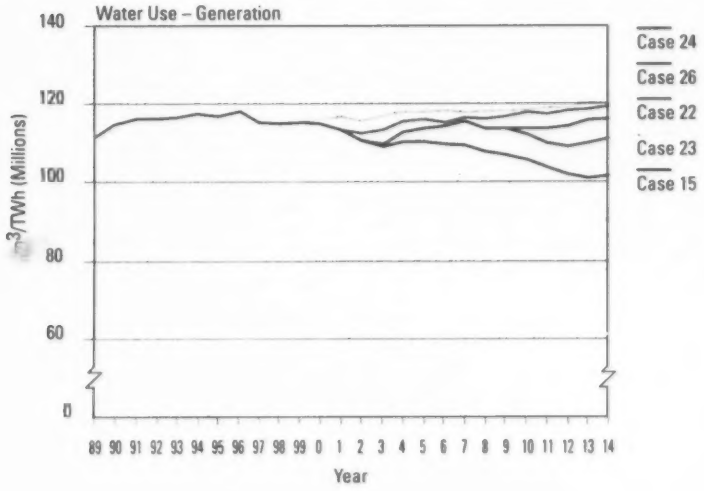
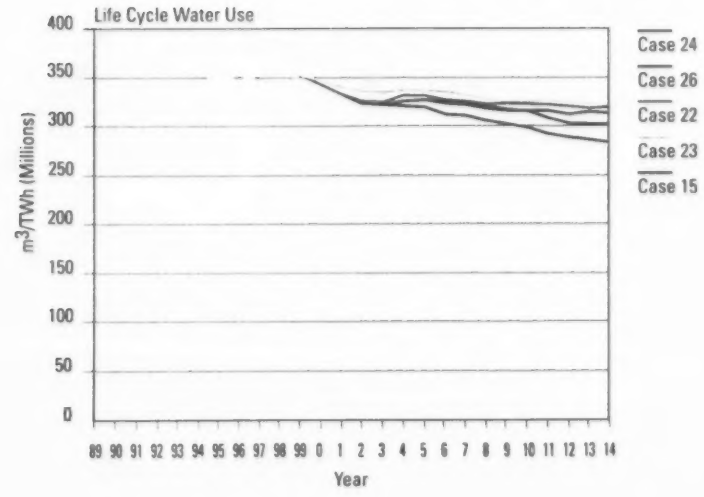


Figure 6-3 **Water Use Index – All Cases**





Transmission requirements dominate total generation-related land use requirements in all 5 planning Cases (Figure 6–4). Taking maximum advantage of opportunities to use existing ROWs for new transmission, and Ontario Hydro's practice of encouraging compatible land uses within its ROWs, will optimize the use of existing and future land holdings and will reduce the net environmental effect. Transmission facilities occupy less than 1% of the total ROW area.

As with ROWs, Hydro's policy is to make maximum use of existing generating station sites before developing new "green" sites and to provide opportunities for compatible secondary uses.

Mining is a major component of life cycle land use in all Cases (Figure 6–4). Most often opportunities for prudent site management and rehabilitation are beyond the direct control of Ontario Hydro, since it neither owns nor operates these mines. It is broadly assumed that regulations are in place to facilitate restoration of these sites when mining ends.

Water Use

Case 26 consumes marginally less water than the other Cases. Life cycle water use (based on normalized values) decreases in all Cases over the study period (Figure 6–3). Normalized cooling water use increases for nuclear-based Cases and decreases for fossil-based Cases, (Figure 6–3). Cooling water constraints for new generation are likely to be site-dependent and could affect cooling system design.

Recent regulatory initiatives suggest that large water users like Ontario Hydro could have to pay more for the water they use. Water rental payments, amounting to about $90 million, anually are currently paid to MNR for water used at hydraulic facilities.

Reducing consumptive uses in the Great Lakes basin will also be a priority. Increased re-use of process and other waste waters at generating stations provides opportunities to reduce long-term water requirements. Reducing waste water effluents is also consistent with the at-source control philosophy of the Municipal Industrial Source Abatement (MISA) Program.

6.1.2 Emissions/Effluents/Wastes

Atmospheric Emissions

All Cases meet current regulatory limits for SO_2, NOx, total acid gas (SO_2 + NOx), and radionuclide emissions. In all Cases, there is a net decrease in SO_2 and total acid gas emissions (on a per TWh basis) over the plan period (Figure 6–5). Annual NOx emissions decline slightly in the nuclear-based and mixed Cases, but remain stable or rise slightly in the fossil-based Cases after the year 2000 (Figure 6–5). Stricter NOx emission limits would be a problem for all cases with upper load growth, particularly from 2000 to 2005. The fossil-based Cases would have difficulty meeting these lower NOx limits over much of the planning period.

At the end of the planning period (Figure 6–8), radionuclide emissions will be marginally higher for the nuclear-based Cases than the fossil-based Cases. Only Case 26 shows a noticeable decrease in radionuclide emissions over the planning period.

As noted previously, SO_2 emissions, are and will continue to be, controlled to meet regulatory limits. Control methods include using low-sulphur coal and installing scrubbers on selected existing coal-fired units. All new coal-fired units will be fitted with scrubbers and SCR, or equivalent NOx control. Total

Figure 6-4 **Typical Water Use and Land Use Allocation for Cases**
Cumulative (1989–2014) Case 15 Median

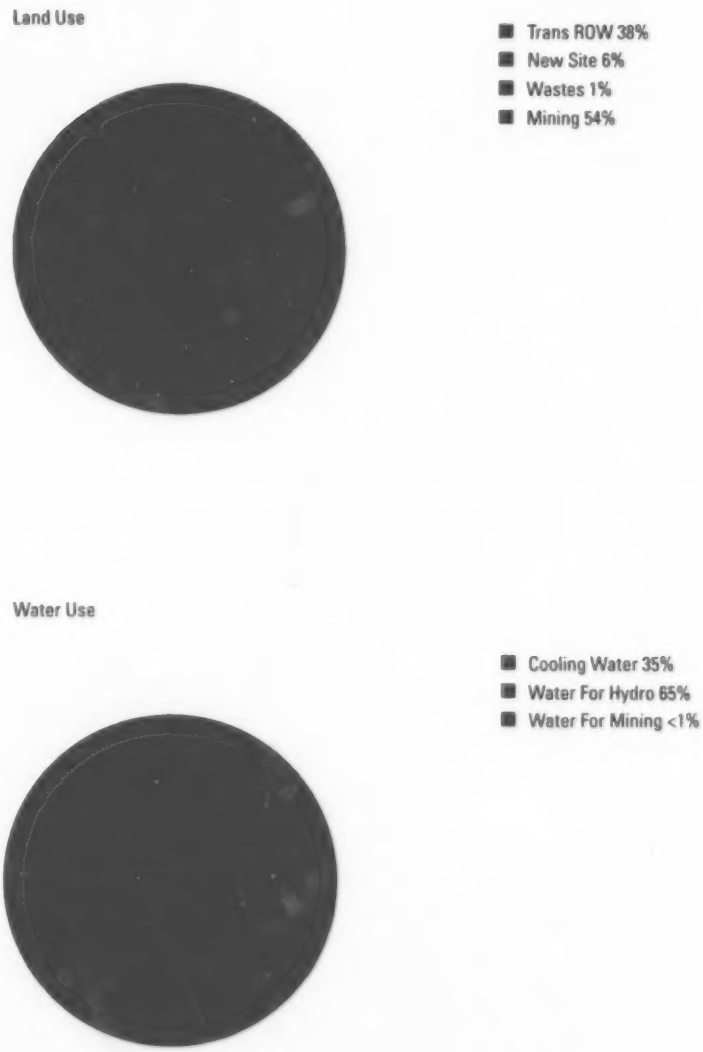


Figure 6–5 **Atmospheric Emission Index – All Cases**

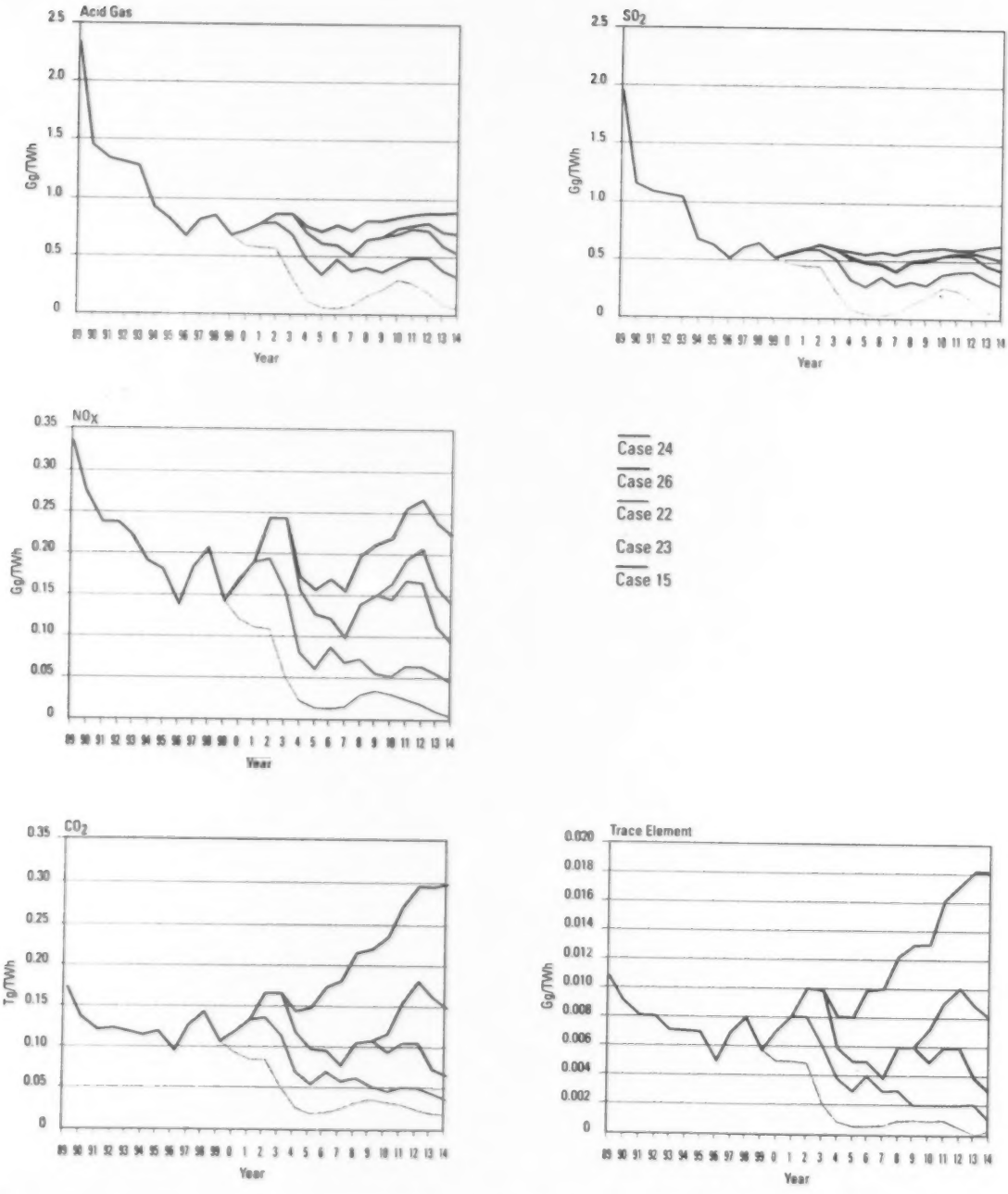
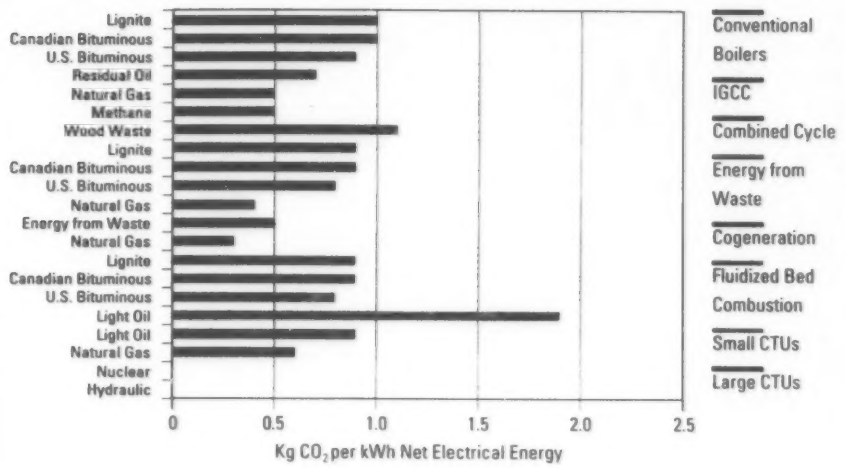


Figure 6–6 **CO_2 Produced by Power Generation Processes**



acid gas emissions remain below current regulatory limits throughout the planning period.

If more stringent NOx emission limits are applied, it may be necessary to install Selective Catalytic Reduction (SCR) or some equivalent high-efficiency NOx control equipment on some, or all, existing coal-fired stations.

CO_2 emissions could be a problem if proposed emission targets are adopted. CO_2 emissions at the end of the study period vary significantly.

A proposed 20% reduction in CO_2 emissions starting in 2005 would pose difficulties for Cases 24 and 26 with median load growth. Upper load growth would cause severe problems for all Cases. Cases 23, 22 and 15 could meet this 20% target with upper load growth (Figure 5–18), but Cases 24 and 26 could not. Options for reducing Ontario Hydro's contribution to the CO_2 problem and dealing with potential effects are discussed in detail elsewhere (Ontario Hydro, 1989c). Many options have already been factored into the alternative Cases (e.g., maximize demand management and system energy efficiency, use lower carbon or non-carbon-producing fuels).

Practical techniques for removing CO_2 directly from the flue gas of fossil-fueled generating stations are not commercially available and would be economically prohibitive. Moreover, disposal of the scrubbed CO_2 would present a substantial problem, given the potentially vast quantities involved. A variety of options are available for reducing or controlling CO_2 emissions. For example, using IGCC as a replacement for conventional CSC coal plants could decrease CO_2 emissions. Avoidance of interim use, or earlier conversion, of CTUs to Combined Cycle units should improve Case performance as CCs have lower CO_2 emission rates than CTUs (Figure 6–6). In addition, the success of non-generation options like Hydro's demand management programs will be extremely impor-

tant in limiting future CO_2 emissions. Reforestation efforts, such as Hydro's tree replacement program, are also important as they would help maintain the vegetative sink needed to absorb future CO_2 emissions. This activity could also provide local employment opportunities, particularly in the northern part of the province.

Aquatic Effluents

Except for variations in coal mine drainage, there is little significant difference in aquatic effluents among Cases (Figure 5–6). There is little variation, as well, in cooling water flows and thermal discharges (Figures 6–3 and 6–8). Cooling water flows are constant or decline slightly over the planning period. Thermal discharge levels rise slightly in the nuclear-based Cases and decline slightly in fossil-based Cases.

At the end of the planning period (Figure 6–7), radionuclide effluents will be marginally higher for the nuclear-based Cases than in the fossil-based Cases. Only Case 26 shows a noticeable decrease in radionuclide effluents.

Opportunities to reduce discharges and promote more extensive water re-use are likely to be driven by the MISA initiative, and increasing concern about consumptive water use in the Great Lakes Basin.

Waste Production

All alternative Cases will produce significant quantities of waste by the end of the study period (Figure 5–7). Normalized total waste production for nuclear-based Cases and the mixed Case decrease over the study period, while production rates for the fossil-based Cases increase (Figure 6–9).

Figure 6-7 **Radionuclide Index – All Cases**

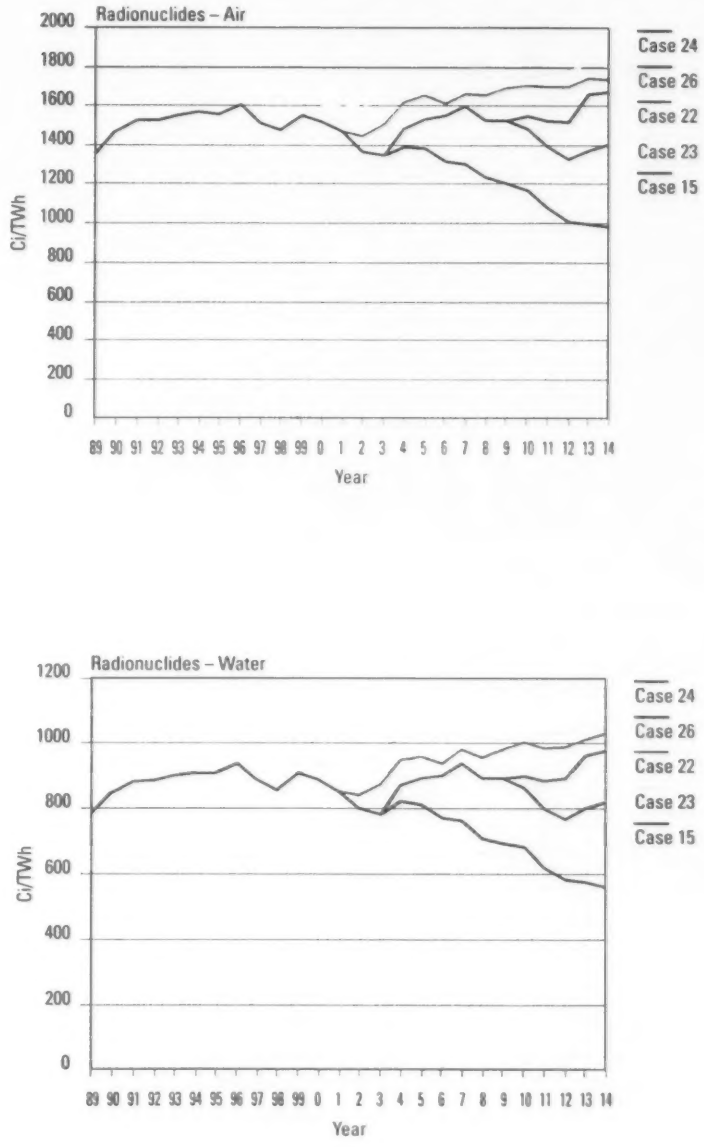
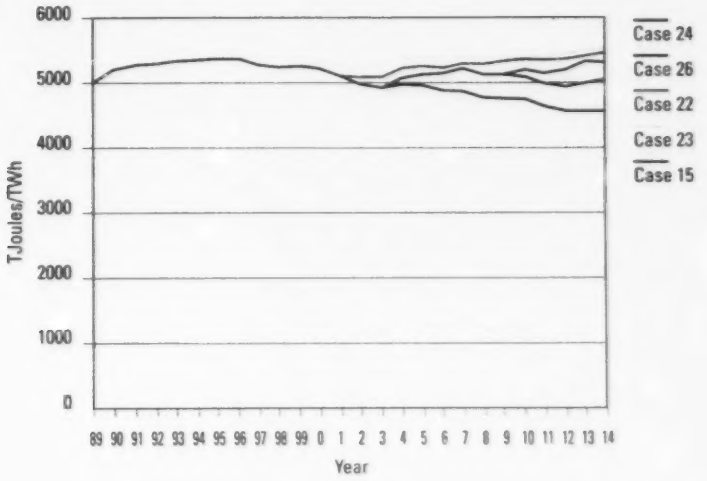


Figure 6-8 **Thermal Discharge Index – All Cases**



The fossil-based Cases produce marginally less radioactive waste than the nuclear-based Cases and the mixed Case.

Recent provincial targets have recommended a 50% reduction in solid waste production in Ontario by 2000. Strategies to reach these targets stress increased waste recycling and re-use. Hydro is currently considering setting recycling/re-use targets for its fossil combustion/control wastes. A number of options are available to significantly reduce waste volumes. For example, a significant amount of fossil-based waste (ash and FGD wastes) could be reduced through more vigorous commitment to waste recycling and re-use programs. Ash from Hydro's coal-fired stations has historically been utilized for a number of constructive purposes, including: replacement/additive material in cement making, backfill material for mines and pit/quarry rehabilitation, and hazardous liquid stabilization. In 1988, about 20% of the ash produced by Hydro's coal-fired stations was recycled. Hydro is actively pursuing a variety of opportunities to expand the re-use of ash. To meet a 50% reduction target, Ontario Hydro would need to significantly expand efforts in this area.

Scrubbing SO_2 from the flue gas at coal-fired stations produces a calcium sulphate (gypsum) waste that can, at an additional cost, be used in commercial grade wallboard. Hydro is negotiating with wallboard manufacturers to develop a market for FGD gypsum to be produced at Lambton GS starting in 1994.

Radioactive wastes have limited potential for re-use. Atomic Energy of Canada Ltd. (AECL) is seeking government approval of a disposal concept for high level radioactive wastes in Canada. Public hearings on this concept are expected to start in 1991.

6.2 Social Environment

6.2.1 Socio-Economic Effects

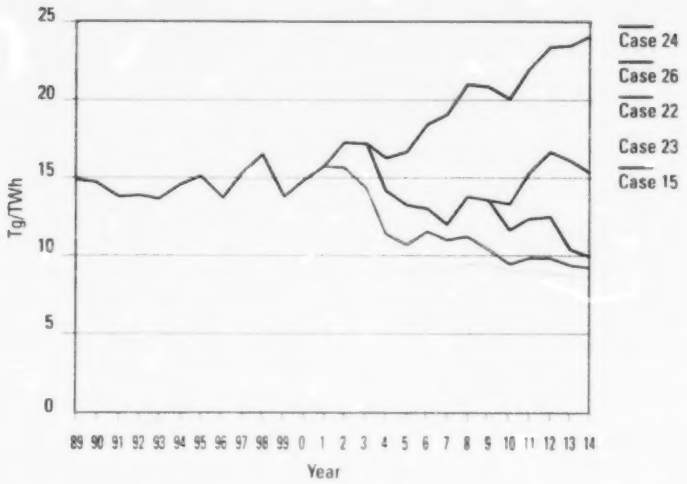
Regional Employment

Demand and supply resources will generate significant employment across the province. Employment created by hydraulic and non-utility generation will be particularly important in the north.

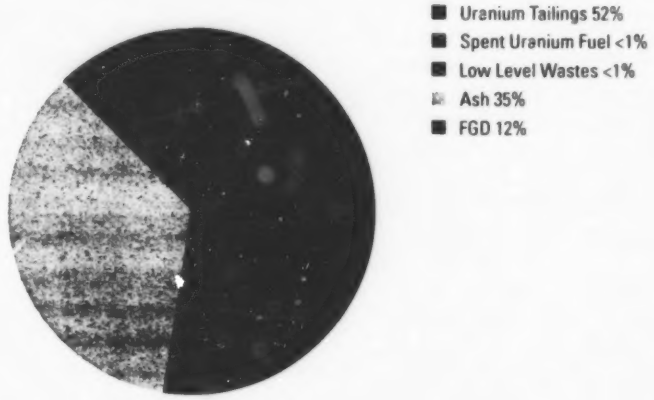
Total employment created by major new supply will not vary significantly among Cases, since all require similar generating capacity. Any differences arise from the labour requirements of the various technologies, site development needed, and indirect and induced employment at various sites. Generally, nuclear projects require the highest employment levels. Levels fall, in turn, for CSC, IGCC, CC, and CTU. New sites and northern projects, which require site development and expansion of infrastructure and regional businesses and services, will generate more employment than expansion of capacity at existing sites.

Hiring depends on the availability and skills of the local workforce. Generally, projects in southern Ontario near major centres are able to draw on local and commuting workers. Projects in northern, or less developed, areas will require an influx of project workers, as well as indirect workers. Northern hydraulic developments are among the most likely to require workers from beyond the local area. To reduce the potential impacts of an influx of population on community facilities and services, and to ensure that the host communities benefit from the project, local hiring is preferred. Facilitating local hiring may require joint initiatives involving Hydro, the trade unions, and governments. These could include

Figure 6-9 **Waste Production Index – All Cases**



Waste – Cumulative (1989–2014) – Case 15 Median



training and apprenticeship programs, and special arrangements for union qualification and hiring.

Case 23 will create the highest level of employment. Case 26, without nuclear, will create somewhat less employment than all other Cases.

Regional Economic Development

Regional economic development stems from many sources. These include the direct effect of material and service purchases, the indirect effects of employee spending, and the development of infrastructure, businesses, and services in affected communities. While generating station projects do not generally attract other industries, improved infrastructure and access and the availability of a skilled workforce can facilitate other economic developments. Significant potential exists for heat energy developments constructed in conjunction with nuclear projects.

While most communities and regions welcome economic development, there are important considerations which must be addressed. These include scale, pace, and compatibility with the existing resources, economic base, and character of the region. Ideally, economic development initiatives should be of a size and pace that enables the community to accommodate growth; makes use of available strengths or resources; and fits with local goals for development.

The most significant opportunities for economic development are hydraulic developments in northern Ontario, particularly the Moose River Basin. While non-utility generation offers limited opportunities, these may be significant in northern or less developed areas. Demand management has limited potential because of its distributed nature.

Large-scale projects in less developed areas of the province offer the largest regional development opportunities.

Local Community Impacts

Any major energy development will affect surrounding communities. The extent and significance of the impacts will depend on how well project characteristics (size, labour requirements and schedule) fit the servicing capacities of those communities. A major factor is the availability of skilled project workers, because the in-migration of workers and families may strain community facilities, services, administration, and financialresources.

Although not necessarily incompatible, there is a potential conflict between the objectives of maximizing regional economic development and minimizing local community impacts. Areas of high unemployment, or areas seeking industrial development or diversification, are often small communities with a limited skilled workforce, limited infrastructure, fewer community facilities and services, and limited experience with major development projects. Consequently, measures are needed to mitigate potential adverse impacts and to ensure that local benefits of employment and economic stimulus are realized. Some measures to enhance local and regional employment and economic development can also help reduce adverse local community impacts. For example, training can reduce the need to move new workers to the area.

Many local community impacts can be avoided, reduced, or mitigated with appropriate impact management programs. These typically include: using construction camps to ease the strain of in-moving workers on the community; assisting or advancing the development of infrastructure such as roads, water and sewage treatment, community facilities for health care, education, recreation, fire and police; and helping strengthen administration and financial management. In the past, Hydro has negotiated community impact agreements with municipalities affected by the Darlington, Atikokan, and Bruce generating stations. The arrangements included monitoring project impacts, liaison with the municipality, and negotiation of financial assistance. A similar process for new major supply will be required.

The development of northern hydraulic facilities will include programs to mitigate any adverse impacts and enhance local benefits.

The other common elements of demand management and non-utility generation will have few or limited community impacts because of their smaller scale and distributed nature.

6.2.2 Societal Considerations

Social Acceptance

All but one of the Cases has a nuclear component. Social acceptance of these Cases will depend heavily on the public's perception of risk and the measures taken to handle such issues as safety and waste management.

The social acceptance of Case 26, with no nuclear component, will depend on the public's perception of the cleanliness of the technologies. The use of scrubbers and IGCCs will likely enhance its social acceptability. Acid gas and greenhouse effects will be a concern.

Special/Sensitive Groups

In Ontario there are many groups of individuals with special interests related to cultural background, socio-economic position, chosen lifestyle, livelihood, or particular concern. Most likely to be affected are environmental, northern, Native, recreational, business, and labour interests.

The common elements will have varying effects. Northern, Native, environmental and recreational interests will be affected by hydraulic developments; community, environmental and health interests will be affected by waste-fueled non-utility generation; low-income or other groups may be unable to take advantage of the benefits of demand management.

With some exceptions, the alternative supply Cases contain the same technologies and thus affect similar special or sensitive interests. All Cases, except Case 26, include nuclear developments, which will be a concern to energy, environmental and community interests. Case 26 has no new nuclear developments but increases the potential effects of fossil generation. All Cases include some fossil generation, which will affect environmental, recreational, resource industry, and health interests concerned about acid rain and the greenhouse effect.

Lifestyle Impacts

Lifestyle impacts occur when people change the routine of their day-to-day lives, or when altered perceptions result in changed attitudes or activities. Examples of lifestyle impacts are: changes in patterns of energy use and daily activities with time-of-use rates; changes in small rural or recreational communities with the coming of a major industrial project; and changes in activities and social patterns because of concerns about public health and safety.

For most Ontarians not directly affected by a supply option or the associated transmission, there will be limited impact on lifestyles. The main sources of change would result from time-of-use or other load- shifting options, changes in use of recreational areas affected by new facilities, or activities undertaken because of strong concerns about environmental or other public issues.

For those in communities affected by supply options or who have a special interest, lifestyle impacts may be significant. Lifestyle impacts are highly likely in northern and Native communities affected by hydraulic developments. Concerns about public health and safety may result in lifestyle changes among some groups in communities affected by nuclear facilities. Communities affected by IGCC or conventional coal projects may also see lifestyle changes because of concerns about the effects of air emissions and dust from coal and ash handling facilities.

Distribution of Risks and Benefits

The benefits of the continued availability of economic, reliable electricity are available across the province and contribute significantly to Ontario's prosperity. The perceived risks of the common elements and the alternative major supply cases are not so evenly distributed, giving rise to equity issues.

The most significant equity issues for the common elements relate to: potential inequities in the access to and in sharing of benefits of demand management initiatives; the impacts on northern and Native communities of

hydraulic develop.ments; and the potential effects of waste-burning non-utility generation. As discussed earlier, these potential inequities can be effectively mitigated.

All Cases include development of major generation facilities. Equity concerns may arise in relation to effects on surrounding areas and it may be necessary to ensure that compensating benefits are captured locally and regionally. All of the Cases, except Case 26, include nuclear generation, thereby raising questions of perceived risk to local residents and to future generations. All Cases rely to varying degrees on fossil generation, with Case 26 exclusively fossil, raising questions of long-term environmental effects, climatic change, and the use of non-renewable resources, particularly oil and natural gas.

6.3 Residual Effects

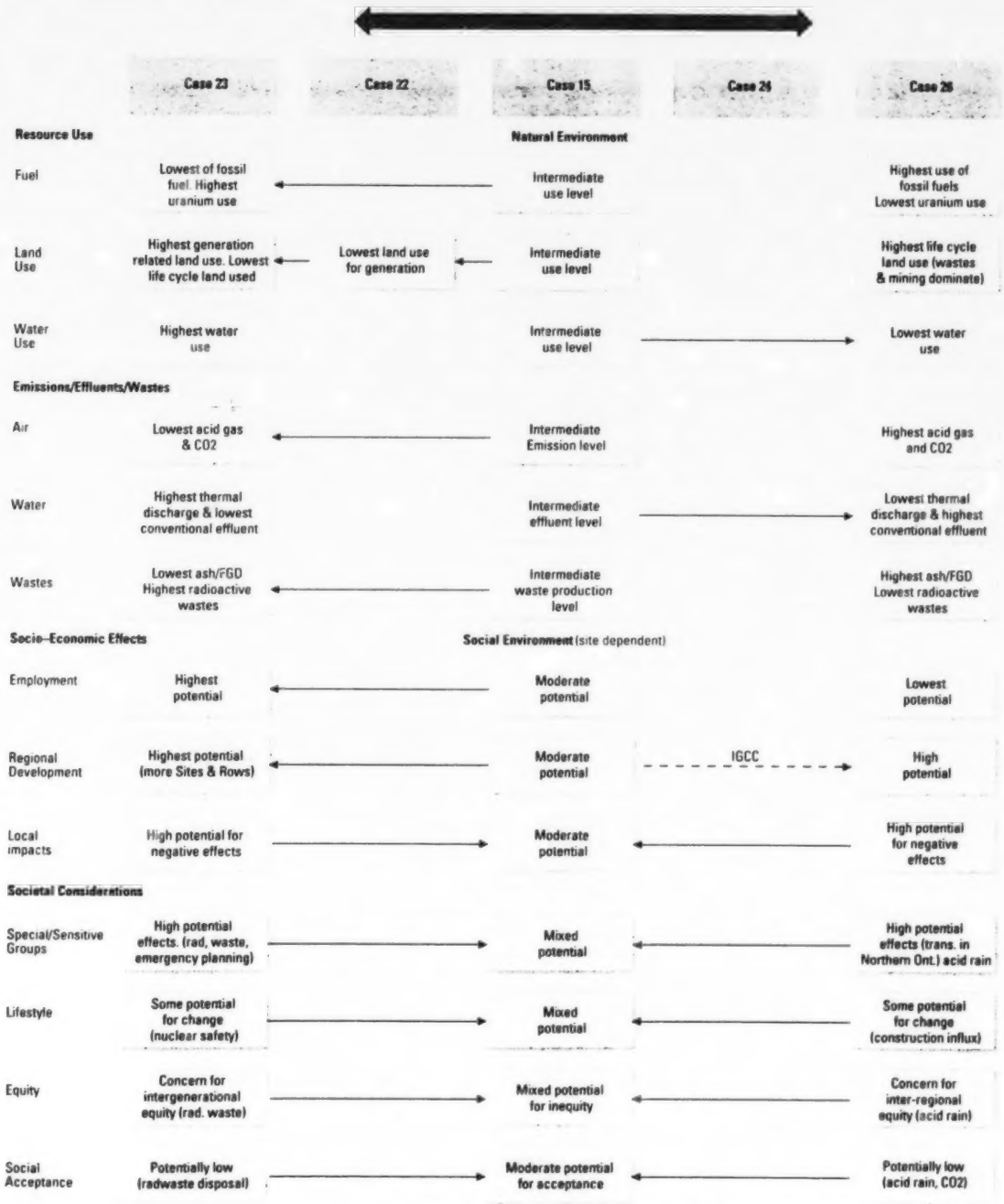
All plans reflect a serious commitment to mitigating and controlling environmental effects. In addition, the plans contemplate that additional demand management programs, and the use of renewable resources for electricity generation, will continue to be given high priority. However, there are residual environmental effects that are evident by the end of the planning period. These include: significant use of non-renewable resources, water and land; emissions of acid gas and CO_2; and production of solid waste. All plans also offer a range of potential social benefits, including increased employment and regional development opportunities. Potential adverse social effects relate to localized community impacts associated mainly with the supply components of a preferred plan.

Ongoing efforts by Ontario Hydro in the following areas will provide opportunities to further reduce residual effects:

- Research and development to facilitate application of best available control technology at existing and new stations to provide continuing reductions in overall system emissions and afford a wider operating margin with respect to existing and anticipated regulations;
- Regular re-evaluations of the trade-offs associated with advancement of the phasing of IGCC or other clean coal technologies, with a view to further reducing acid gas and CO_2 emissions, and waste volumes, over the long term;
- Continued and expanded commitment to waste re-use and recycling programs, particularly in the area of fossil combustion and emission control wastes;
- Continued and expanded commitment to water re-use and recycling to reduce consumptive water use and reduce discharges to Ontario waterbodies;
- Continued and expanded support for waste heat utilization projects (e.g., aquaculture) to reduce thermal discharges to the environment;
- Continued and expanded commitment to promoting compatible uses of land at generating stations and along rights-of-way;
- Continued and expanded commitment to reforestation efforts to offset vegetation losses due to hydraulic flooding and transmission right-of-way clearing. This has ancillary benefits of increasing the CO_2 absorbing vegetative sink in Ontario and providing local employment opportunities;
- Continued commitment to public consultation and community impact management in dealing with potentially affected individuals and communities.

Implementation of these measures will involve weighing their benefits against financial

Figure 6–10 **Environmental Analysis Summary**



and other societal considerations, to ensure that an appropriate balance is struck between Ontario's electricity use and its desire to maintain a high level of environmental quality.

6.4 Conclusions

The environmental advantages and disadvantages of the alternative Cases are summarized in Figure 6–10. The arrows give a general indication of preference. It is important to recognize that tradeoffs and mitigation measures are necessary for all alternative plans.

The following conclusions can be drawn from the environmental analysis:

General

- None of the alternative plans is clearly superior with respect to all natural and social environmental criteria considered.
- Achieving acceptable environmental effects for the alternative plans will require careful siting, design, construction, and mitigation measures for the various plan components. Project environmental assessments will address these factors.

Common Elements

- The high priority common elements in the plans generally reduce the need for future major supply and promote the utilization of renewable resources.

Demand management options are generally favoured from an environmental viewpoint, since the focus of these programs is on using energy more efficiently, thereby reducing energy use for the same level of service.

Hydraulic generation, certain types of non-utility generation, and the Manitoba purchase provide the only true renewable energy sources utilized in each plan. There will, however, be environmental effects associated with pursuing these options. Environmental assessments will be carried out, as required, to ensure that these projects are implemented in an environmentally acceptable manner.

Hydro's continuing efforts to increase the contribution from the common elements, particularly those related to demand management and renewable resource use, are important for increasing the plans' long-term environmental sustainability and social acceptance.

Major Supply Cases

- Front-end fuel cycle impacts (i.e., mining) significantly affect the wastes produced and amount of land utilized by each plan. Most of these impacts are beyond the direct control of Ontario Hydro. It is assumed, however, that these activities will be regulated to meet appropriate environmental standards, and that the costs of any remedial measures (e.g., site management and reclamation) are reflected in the price of purchased fuels.
- Nuclear-based Cases tend to have the lowest system non-renewable resource use, atmospheric emissions, and total waste production. However, they produce higher amounts of radioactive waste and utilize higher quantities of water. While these radioactive emissions/wastes are well managed, they represent a source of public concern.
- Fossil-based Cases tend to have the lowest radioactive waste production and water use. However, they consume the highest quantities of non-renewable resources and produce significantly higher acid gas and CO_2 emissions, and waste volumes. While these Cases meet current regulatory limits on emissions and wastes, problems like acid rain and the greenhouse effect are a source of public concern.
- A Case that utilizes a mix of both fossil and nuclear generation provides a "middle ground" in that it has an intermediate level of non-renewable resource use, atmospheric emissions, water use, aquatic effluents, and waste production. However, public concerns related to both forms of generation will have to be reconciled.
- Regulations related to the environment are expected to tighten, requiring reduced emission levels and increased levels of control. Meeting these regulatory limits will be more difficult for the fossil-based Cases, particularly under upper load growth.
- There are residual environmental effects. Ontario Hydro is committed to pursuing a variety of measures which offer the potential for further mitigating the residual environmental effects of the Demand/Supply Plan.

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GLOSSARY OF TERMS AND ABBREVIATIONS

ACID DEPOSITION – a process by which substances capable of chemically donating a positive hydrogen ion are deposited on the earth's surface, thereby tending to shift receiving substances towards the acid end of the pH scale. Deposition may occur during precipitation by removal of suspended or gaseous material from the air (commonly referred to as acid rain), or in dry form when particles are deposited or absorbed onto surfaces.

ACID GAS – refers to the emissions of SO_2 and NO_x which are the precursors of acid rain.

ACID MINE DRAINAGE – the solutions leaving a mine which contain certain oxides that react with water to form acids i.e. solutions in which the hydrogen ion concentration is greater than 10^{-7}.

ACID RAIN – a technically incorrect, but generally accepted synonym for acidic precipitation. It includes rain, snow, sleet and hail having an acidity below pH 5.6. Acid rain is the primary result of emissions of sulphur oxides (SO_2) and nitrogen oxides (NO_x), which are transformed into sulphuric acid and nitric acid, respectively, as they are transported by the atmosphere over distances of hundreds to thousands of kilometres.

AECB (Atomic Energy Control Board) – the organization established by the Atomic Energy Control Act of 1946 "to make provision for the control and supervision of the development, application, and use of atomic energy and to enable Canada to participate effectively in measures of international control of atomic energy". Thus, the AECB, via a comprehensive licensing and inspecting system, is responsible for the health and security aspects of nuclear energy.

AECL (Atomic Energy of Canada Limited) – a Canadian federal crown corporation that researches, designs, develops, applies and markets nuclear technologies in Canada and globally. The groups include nuclear waste management, CANDU reactor development, physics and health sciences and radiation applications and isotope sales.

A.L.A.R.A. (As Low As Reasonably Achievable) – a principle, promoted by Ontario Hydro, which is based on cost-benefit analysis and is reached when the socio-economic gains achieved by further reducing a risk are equal to the socio-economic costs of achieving that reduction.

BACTEA (Best Available Control Technology Economically Available) – pollution emission control technology which will offer the best performance, yet is economically feasible.

BAGHOUSE – a large chamber or room for holding bag filters used to remove particulate from gas streams in a furnace.

BASE LOAD GENERATION – a generating station expected to operate at 60% capacity factor or higher.

BETA PARTICLES – an electron or positron emitted by many radionuclides during radioactive decay. It can penetrate body tissue to a depth of 1 – 2 cm. It can cause both skin burns and pose internal exposure hazards to humans and animals.

BOTTOM ASH – a combination of inorganic heavy ash particulates and molten slag that forms on the internal surfaces of a boiler after the combustion of coal in a generating station. It constitutes about 10 – 20% of total ash production. Most, if not all, of this ash is used on-site for road construction and/or landscaping purposes at coal-fired stations.

BULK ELECTRICAL SYSTEM (BES) – the integrated system of transmission lines and stations by which electric power is delivered from major generating stations to and between load centers, and to and from interconnections with neighbouring utilities.

CALANDRIA TUBES – the tubes in a CANDU nuclear reactor that provide containment and support for the in-core portions of the fuel channels and isolate the pressure tubes from direct contact with the heavy water moderator.

CANDU – a Canadian developed nuclear power reactor system. The name is derived from CANadian Deuterium Uranium, indicating that the moderator is deuterium or heavy water and that the fuel is natural uranium.

CAPACITY – the numerical measure used to indicate "size". For generating stations the measurement is in megawatts (MW) or kilowatts (kw).

CARBON MONOXIDE (CO) – a colourless, odourless, highly toxic gas that is a normal by-product of incomplete fossil fuel combustion. CO, one of the major air pollutants, can be harmful in small amounts if breathed over a certain period of time.

CC (Combined Cycle) – a high efficiency, moderate capital-cost technology. It involves generating electricity using a gas turbine, and diverting the exhaust gases into a heat recovery boiler to create steam. This steam drives a turbine, which generates additional electricity.

CFC (chlorofluorocarbons) – a chemical compound used as an aerosol propellant, solvent, and refrigerant. It is believed to be a contributor to the depletion of the ozone layer, as well as a strong greenhouse gas.

Ci (curie) – a measure of the rate at which a radioactive material disintegrates. One curie corresponds to 37 billion disintegrations per second.

CO_2 (carbon dioxide) – a colourless gas produced by the complete combustion of carbon, by the actions of acids on carbonates, by the thermal decomposition of carbonates (e.g. lime burning) and during fermentation. It

is one of the gases known to contribute to the greenhouse effect.

COAL MINING WASTE – refers to solid and liquid wastes created from the mining and processing of coal. These include overburden, refuse from coal washing and preparation, which consists of coal waste and other impurities, and sludge resulting from the treatment of acid mine drainage.

COGENERATION –the ability to generate electricity and heat, usually in the form of steam, at the same time.

COMMUNITY IMPACT AGREEMENT (CIA) – a mitigation and/or compensation agreement with a host community, where the social fabric and infrastructure are affected for a limited time by the construction, operation or decommissioning of any major Ontario Hydro facility. For irreversible effects, it can provide a lump sum payment by Ontario Hydro.

COMMUNITY IMPACT MANAGEMENT PROGRAM – a process for reaching agreements, plans for mitigation, compensation, contingency planning and community liaison. It is based on negotiation between Ontario Hydro and affected communities, and can result in a CIA.

CONVENTIONAL WASTES – wastes other than radioactive wastes produced at Ontario Hydro generating stations.

COOLING TOWER – a mechanical device used to remove excess heat from cooling water used in industrial operations, particularly in electric power generation.

COOLING WATER SYSTEM – includes intake and discharge of water for condenser cooling purposes at thermal generating stations.

CPM (Combustion Process Modification) – a type of NO_x control that involves changing the combustion process at a fossil station (usually changing the burners) to reduce combustion temperatures required, and thereby reducing NO_x production.

CTU (Combustion Turbine Unit) – a generator driven by an engine fuelled by some form of refined petroleum product, usually diesel fuel, oil or natural gas.

DEMAND – the power and energy that must be generated to meet customer needs; includes delivery losses.

DEMAND MANAGEMENT – measures taken by Ontario Hydro and municipal utilities to influence the amount and timing of customer electricity demand.

DERIVED EMISSION LIMITS (DEL) – the allowed amount of radiation released per year, based on the AECB public dose limit. DELs are station-specific and are conservative (probably high) estimates of the maximum permissible average release rates of radioactivity, averaged over a specified time (i.e. a year).

DEUTERIUM (D_2O)- a stable, naturally occurring hydrogen isotope. In the form of heavy water, it is an effective neutron moderator in nuclear reactors.

EAST-WEST TIE – a transmission system linking eastern (east of Wawa) and western (west of Wawa) portions of Ontario Hydro's BES.

ELECTROSTATIC PRECIPITATOR (ESP) – an air pollution control device used to remove particulates from a gas stream by charging them with an electrode and then collecting them on an oppositely charged plate.

EMF (electromagnetic field) EFFECTS – the biological effects of electric and magnetic fields generated by transmission lines and other electrical devices.

ENERGY EFFICIENCY IMPROVEMENTS – methods of improving the efficiency of a generating unit or the end-use of electricity.

ENERGY-FROM-WASTE (EFW) – the use of waste products (e.g. scrap wood or refuse) for power generation by burning the waste to create steam.

ENTRAINMENT – the exposure of non-filterable organisms, like plankton, to mechanical, pressure and thermal experiences of the heat exchange system.

ENTRAPMENT – the capture of organisms in cooling water at the intake of cooling water systems.

ENVIRONMENT – according to the Environmental Assessment Act, the environment consists of,

a. air, land or water;

b. plant and animal life, including man;

c. the social, economic and cultural conditions that influence the life of man or a community;

d. any buildings, structure, machine or other device or thing made by man;

e. any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from the activities of man; or

f. any part or combination of the foregoing and the interrelationships between any two or more of them.

FGD (flue gas desulphurization) – process in which sulphur dioxide is removed from the flue gas of a fossil-fueled generating station; synonymous with scrubbers.

FGD WASTE – a sulphite/sulphate rich material derived from FGD. Oxidized forms of this material (e.g. calcium sulphate ($CaCO_3$)) can provide a source of commercial, wallboard-quality gypsum.

FLUE GAS – a mixture of gases (e.g. SO_2, CO_2, NO_x) resulting from combustion of hydrocarbon based fuels.

FLUE GAS CONDITIONING – involves injecting a mixture of ammonia (NH_3) and sulphur trioxide (SO_3) into the flue gas at a coal-fired generating station to control opacity levels.

This process is necessary to allow expanded use of low sulphur coal at existing coal-fired stations.

FLY ASH – the fine, non-combustible particulate material derived from fossil fuel combustion that is transported out of the boiler in the flue gases and collected in an ESP or baghouse for disposal or reuse. Fly ash typically consists of aluminum, silica and unburned carbon, as well as other trace elements. It is classified as a non-hazardous industrial waste by the Ministry of the Environment.

FUGITIVE DUST – airborne particles (e.g. coal dust, coal ash, or other dry bulk material) that escape from an uncontained mass of material during handling, storage or transportation.

GAMMA RAY – high energy, highly penetrating electromagnetic photons of short wavelength commonly emitted by a nucleus of a radioactive atom during radioactive decay, as a result of a transition from an excited energy level to a lower level.

Gg (gigagrams) – 10^9 grams or one billion grams.

GREENHOUSE EFFECT – a naturally occurring process whereby certain greenhouse gases, mainly CO_2, vapour, clouds and trace gases in the atmosphere allow the sun's ultraviolet and visible radiation to penetrate and warm the earth, but then absorb the infrared energy from the earth and radiate it back into the atmosphere. By blocking the escape of this outgoing radiation these gases effectively contribute to a warming of the earth's atmosphere. It is predicted that continued increases in anthropogenic emissions of certain gases (e.g. CO_2, CFCs) will accelerate this effect and dramatically increase rates of global warming.

GREENHOUSE GASES – gases that contribute to global greenhouse warming. Potentially important radiative gases include CO_2, water vapour, methane, CFCs, ozone, N_2O/NO_x, CO, SO_2, and carbonyl sulphide (COS).

GROSS BETA/GAMMA – a radiation exposure/release based on an all inclusive radiation field from beta particles and gamma rays without differentiating them. This radiation field is measured at the station and is not radionuclide-specific. It is used in the determination of the DEL.

HALF-LIFE – the time for half the atoms of a radioactive substance to disintegrate; hence the time to lose half its radioactive strength (ranges from seconds to billions of years).

HEAVY WATER – deuterium oxide, D_2O, the moderator and heat transport fluid used in CANDU reactors.

HGD – Hydroelectric Generation Development.

HYDROGEN SULPHIDE (H_2S) – a by-product of heavy water produced at nuclear generating stations, as well as the gasification process for IGCC. It is an acutely dangerous poison to the central nervous system and respiratory system at 400 ppm, a strong irritant of the eye and respiratory tract at 100 ppm, and a slight irritant at 10 ppm. Chronic exposure to low levels may produce pulmonary edema.

I_{131} (Iodine$_{131}$) – a radioactive isotope of iodine having a short-term dose significance and half-life of approximately eight days.

IGCC (Integrated Gasification Combined Cycle) – one of several "clean coal" generation alternatives. Coal is fed to the gasifier where it reacts with steam and oxygen (or air) to produce a hot raw fuel gas which is cooled and purified to remove particulates and acid gas (mainly hydrogen sulphide). Elemental sulphur is recovered from the H_2S rich stream removed by the acid gas removal process. The clean fuel gas is burned in combustion turbines. The hot flue gas leaving the combustion turbines is cooled by generating, superheating, and reheating steam, which is utilized in steam turbines. Power is generated from both the combustion and steam turbines.

IMPINGEMENT – the retention of organisms, principally fish, on cooling water screening systems.

IN-SERVICE DATE – the date a generating unit is declared available for operation.

INTERCONNECTION – a transmission line which can carry power across the boundaries of service areas of adjacent electric utilities (e.g. Hydro Quebec).

INTERMEDIATE RADIOACTIVE WASTES – wastes requiring shielding; includes ion exchange columns, filters, filter cartridges and bulk resins.

ISOTOPE – species of an atom with the same number of protons in its nucleus as other isotopes of the same element, but differing in the number of neutrons.

KILOWATT (kw) – a unit of electrical power equal to 1,000 watts.

KILOWATTHOUR (kwh) – a unit of electrical energy or work, equal to that done by one kilowatt acting for one hour.

LOAD –electricity (peak power and energy) consumed to meet customer electricity needs; synonymous with customer load.

LOAD SHIFTING – a program designed to redistribute demand throughout a time period so as to use the power system more effectively (e.g. encouraging off-peak and night-time use). The total amount of electricity consumed is not affected by load shifting.

LONG-TERM EFFECTS – those effects resulting from the design, construction or maintenance of a facility which persist long after restoration activities have been carried out.

LOW LEVEL RADIOACTIVE WASTE – wastes that do not normally require shielding. They fall into two categories – compactible wastes, which include cellulose and plastic trash; and non-compactible wastes, including metallic wastes (e.g. equipment, ash containers).

Mg (megagrams) – 10^6 grams or one million grams.

MISA (Municipal Industrial Strategy for Abatement) – a control program, introduced by the Ontario Ministry of the Environment in 1986, aimed at the virtual elimination of toxic contaminants in municipal and industrial discharges into Ontario waterways. Specific regulations are being developed for the electrical generation sector (i.e., Ontario Hydro).

MOE – Ontario Ministry of the Environment.

MW (megawatts) – one million watts or one thousand kilowatts. It is a means of indicating the power rating of equipment (e.g. electrical power of a generator or thermal power of a nuclear reactor).

NOBLE GASES – chemically inert gases. Fission product noble gases consist of isotopes of Xenon, Krypton and Argon-41 produced by neutron activation of trace quantities of Argon-40 in air.

NON-RENEWABLE RESOURCE – a resource that cannot be naturally replaced within a reasonable period of time. Examples include oil, natural gas, coal, uranium and metal minerals.

NON-UTILITY GENERATION (NUG) – electrical generation in Ontario owned and operated by electricity producers other than Ontario Hydro; includes private and municipal utilities, and private power producers.

NO_x (nitric oxide) – a gas formed in great part from atmospheric nitrogen and oxygen when combustion takes place under high temperatures and pressures, as in internal combustion engines. NO_x is not itself a pollutant. However, in the ambient air, it converts to nitrogen dioxide (NO_x), a major contributor to photochemical smog or ozone. Forms of NO_x are precursors to acid rain and greenhouse gases.

OFF-PEAK – power use outside of high demand (peak) periods.

ONCE THROUGH COOLING (OTC) – a method of providing condenser cooling requirements for a thermal generating station. Water enters the OTC system through an intake tunnel or channel, is filtered and treated as necessary, before entering the condenser and being returned at an elevated temperature to the source water body via a discharge tunnel/channel. Water consumption is limited to evaporative losses in the system. Discharge temperatures are typically less than 15°C above ambient water body temperature.

OPACITY – the degree of transparency of a material. For example, low opacity would indicate a high transparency. In water, opacity is measured by a parameter referred to as turbidity.

PCB (polychlorinated biphenyls) – synthetic chlorinated hydrocarbons with properties of low flammability and high chemical and thermal stability. PCBs are used in the manufacture of plastics and have been used in the electrical industry as transformer and capacitor fluids. PCBs are highly toxic to aquatic life, persist in the environment for long periods of time, and are biologically accumulative.

PEAK / PEAKING – the highest average load during a time interval of specified duration, e.g. 20 minutes, occurring during a given period of time, e.g. in a day.

RADIOACTIVE WASTE – used fuel and low and intermediate level nuclear waste derived from the operation, maintenance, rehabilitation and decommissioning of nuclear generating stations. These materials have no foreseeable value. Because they contain or are contaminated with radioactivity, special measures are needed to ensure radiation protection of workers and the public.

RADIONUCLIDE – any nuclide (isotope of an element) which is unstable and undergoes natural radioactive decay.

RADON (Ra) – one of the chemical elements; the isotope of mass 222 has an approximate half-life of 38 seconds.

RCEPP (Royal Commission on Electric Power Planning) – a 1970s commission set up to examine the long-range electric power planning of Ontario Hydro.

RECYCLING – reuse of a waste product for a beneficial purpose (e.g. using fly ash as an additive in the cement industry.)

REDEVELOPMENT – reuse of an existing site for a new generating facility; steps taken to make possible the use of an existing hydraulic resource beyond the expected life of the facility.

RENEWABLE RESOURCE – a resource where supply can be replaced (naturally or with human intervention) as it is used, or within a recoverable time-frame. Examples include forests, water, fisheries and hydroelectric generation.

RESOURCE – something that can be drawn on to meet a need; in Plan Report, has particular meaning with respect to primary energy resources such as hydraulic, uranium, oil, natural gas, solar, wind

ROW (Right-Of-Way) – the actual area required by Ontario Hydro to construct and operate an electrical transmission line.

SCR (Selective Catalytic Reduction) – a process in which nitrogen oxides are removed from the flue gas of a fossil-fueled generating station

SCRUBBER –see FGD.

SHORT-TERM EFFECTS – those effects resulting from the design, construction or maintenance of a facility which are a direct result of construction activities, are of limited duration and can usually be eliminated through restoration measures and/or natural processes.

SILTATION – a process whereby a river or stream is filled or choked-up with silts so as to impede the flow of water.

SO_2 (sulphur dioxide) – a heavy, pungent, colourless gas primarily formed by the combustion of fossil fuels. SO_2 can damage the mammalian respiratory tracts, as well as vegetation and materials. It is a major pollutant resulting from fossil fuel (mainly coal) combustion and a precursor to acid rain.

SUSTAINABLE DEVELOPMENT – economic development which does not damage the environment and "meets the needs of the present without compromising the ability of future generations to meet their own needs."

TEMPERING – the process whereby condenser discharged water is mixed with lake water to reduce its temperature before returning to the lake.

THERMAL DISCHARGE – the heat discharged into water as a result of the condenser cooling process involved in electrical generation (see OTC).

THERMAL GENERATING STATION – fossil- or nuclear-based generation.

Tg (Teragram)– 10^{12} grams or one trillion grams.

TRACE ELEMENT – a chemical element (e.g. iron, copper, zinc, etc.) which is present in only a minute quantity. The following elements are the dominant trace elements associated with fossil fuel combustion: Fluorine (Fl); Iron (Fe); Titanium (Ti); Bromine (Br); Boron (B);and Barium (Ba).

TRF (Tritium Removal Facility) – a plant designed to clean all tritiated heavy water (see tritium) from the Darlington, Pickering and Bruce nuclear generating stations.

TRITIUM – a radioactive form of hydrogen that emits low energy radiation and is created as a by-product of the fission process. It occurs naturally in the upper atmosphere and is produced in heavy water moderated CANDU nuclear reactors, when deuterium captures a neutron. It has a half-life of approximately 12 years, and eventually becomes harmless helium gas. Biologically, its half-life in the human body is about 10 years, because of the gradual replacement of body water by fluid consumption. Heavy water that becomes contaminated with tritium is called "tritiated heavy water."

TWh (terawatthour) – one terawatthour equals one billion kilowatthours. Energy made available by Ontario Hydro to Ontario customers in 1985 was about 116 TWh.

UNEP (United Nations Environment Program) – a program that was the product of the 1972 Stockholm Conference on the Environment that stressed the importance of global environmental protection.

URANIUM TAILINGS – the solid and liquid wastes produced from the mining and milling of uranium. The principal wastes include the solid mined rock from which the uranium is taken and liquid effluents produced through the milling process. These tailings are naturally radioactive and include the natural products of the uranium decay chain, such as Uranium-234, Thorium-234, Radium-226 and Uranium-234.

UREA INJECTION – a post-combustion NO_x control technology that uses an aqueous solution, containing urea and/or chemical enhancers, that is injected into the products of combustion. Urea reacts with nitrogen oxides in the combustion gas to form nitrogen gas, water, and carbon dioxide. Excess urea degrades to nitrogen, carbon dioxide and small amounts of ammonia.

USED FUEL – nuclear fuel bundles that have been irradiated in a reactor, and hence become radioactive. They account for more than 99% of the radioactivity in a nuclear plant.

WASTE – a general term that refers to both conventional and radioactive wastes. See fly and bottom ash, radioactive waste, uranium tailings, and coal mining waste.

WATT (W) – a measure of electrical power, i.e., a 100-watt lightbulb.

APPENDIX A - NATURAL AND SOCIAL ENVIRONMENTAL CRITERIA - ASSUMPTIONS & EMISSIONS

Appendix A – Natural and Social Environment Evaluation Assumptions

Natural Environment

SO_2 and NOx control measures, required to meet regulatory limits specified in Ontario Regulation 281/87, are implemented in the major supply cases and have been included in the cost evaluation of the plans. Coal prices included costs required for coal mine site management and rehabilitation.

Nuclear generation costs include station decommissioning and long–term disposal of used fuel.

Flue gas desulphurization (FGD) and selective catalytic reduction (SCR) equipment, or equilavent NOx equipment, will be used for fossil stations as required to ensure acid gas emission levels do not exceed the limits of Ontario Regulation 281/87.

A 20 percent reduction in (1987) CO_2 emissions by 2005 is anticipated. A Federal-Provincial accord on CO_2 emissions is expected within the study period.

Atmospheric emissions from nuclear generating stations will be, on an average annual basis, controlled to about one percent of the Derived Emission Limits (DEL) set by the Atomic Energy Control Board (AECB).

Installed FGD systems will be capable of producing wallboard quality synthetic gypsum.

Non-utility generation (NUG) will be primarily gas-fired with some hydraulic development.

Darlington type cooling water systems (offshore intake and discharge) will be used for all future stations on the Great Lakes

All used nuclear fuel produced during the study period will ultimately be disposed in a centralized nuclear fuel waste management centre developed by AECL.

Plan comparisons are based on an evaluation of potential environmental impacts associated with energy production and/or capacity additions (1989 – 2014). Effects are assessed as being largely proportional to emission level, water or land use, or waste production.

"Typical" values, used for atmospheric emissions, water use, land use and waste production, are summarized in Table A-1. These are mainly derived from a review of current and past system planning and operating experience. Land area estimates are based on typical site area requirements for fossil and nuclear stations and total area flooded by new hydroelectric facilities.

Any new site is assumed to require 1000 ha of land area.

Natural Environmental Analysis
Typical Factors Used for Calculation of Parameter Values

Parameter			
A. Resource Use			
Fuel			
1. Coal	US Coal: (TWh x (3.413×10^5) / WCC Coal: (TWh x 4.689×10^5)	Megagrams	(Mg)
2. Oil	TWh x (1.575×10^6) x (1.59×10^7)	Gigaliters	(Gl)
3. Gas	TWh x 24	Gigacubicmeters	(Gm^3)
4. Uranium	TWh x 19	Megagrams	(Mg)
Water Use			
1. Water (Cooling Water)	Nuclear: TWh x (1.8×10^8) / Fossil: TWh x (7.0×10^7)	Cubic Meters	(m^3)
2. Water (Mining) – Nuclear	$TWh_{nuclear}$ x 2779.5	Cubic Meters	(m^3)
– Conventional	TWh_{fossil} x 1515.15	Cubic Meters	(m^3)
3. Water (Generation)	$TWh_{hydroelectric}$ x (1.0×10^9)	Cubic Meters	(m^3)
Land Use			
1. Land (Mining) – Nuclear	$TWh_{nuclear}$ x (6.81 (mine area) + $TWh_{nuclear}$ (1.197 (tailings))	Hectares	(Ha)
– Fossil	TWh_{fossil} x 2.8 + (Mg Ash/FGD x 1.54×10^{-5}) + (Mg limestone x 8×10^{-6})	Hectares	(Ha)
2. Land (Generation related)	New sites + New Transmission + Reservoir Flooded Losses	Hectares	(Ha)
Other			
1. Limestone (for FGD)	$TWh_{scrubbed\ coal}$ x (2.43×10^4)	Megagrams	(Mg)
B. Emissions / Effluents / Wastes			
Atmospheric Emissions			
1. SO_2	Based on sulphur content of fossil fuel mix and scrubbing efficiencies	Teragrams	(Tg)
2. NOx	Based on fossil fuel mix and technology used	Teragrams	(Tg)
3. Total Acid Gas	(SO_2 + NOx)	Teragrams	(Tg)
4. CO_2	Based on mass of fossil fuel combustion	Teragrams	(Tg)
5. Radionuclides	Cumulative releases of radiation from tritium, noble gases, I^{131}, and particulates	Curies	(Ci)
6. Trace Elements (conventional)	TWh_{fossil} x 5.29×10^2 (see appendix A-2)	Gigagrams	(Gg)

Natural Environmental Analysis

Approximated Factors Used for Calculation of Parameter Values

Parameter			
Aquatic Effluents			
1. Thermal Discharge	$((TWh_{nuclear} \times 2.12) + (TWh_{fossil} \times 1.32)) \times 3600$	Terajoules	(Tj)
2. Radionuclides	Based on cumulative releases of tritium and gross beta emissions	Curies	(Ci)
3. Uranium Mining Effluent	$TWh_{nuclear} \times 2779.5$	Megagrams	(Mg)
4. Coal Mining Effluent	$TWh_{fossil} \times 1515.15$	Megagrams	(Mg)
Wastes			
1. Coal Ash	US coal used x .0741 + WC coal used x .1114	Megagrams	(Mg)
2. FGD Wastes	Scrubbed Coal TWh x 46111	Megagrams	(Mg)
3. Used Nuclear Fuel	$TWh_{nuclear} \times 19$	Megagrams	(Mg)
4. Low Level Radioactive Waste	$TWh_{nuclear} \times 7.6$	Megagrams	(Mg)
5. Uranium Mine Tailings	$TWh_{nuclear} \times 11970$	Megagrams	(Mg)
6. Total Wastes	Sum of wastes 1 thru 5		

Social Evaluation Assumptions

Maximizing employee opportunities for local workers, rather than importing a large number of workers from other geographic areas of the province or Canada, is preferred. This helps to reduce the adverse effects of a population influx on local facilities and services and helps ensure that the area that experiences adverse effects also receives employment and investment benefits.

Regional development is desirable. Regional development in northern Ontario is preferred over regional development in south-central Ontario.

Impacts on the size and service infrastructure of a community should be minimized or offset by appropriate mitigation such as community impact grants.

Peoples' perceptions of the risks associated with the various components of the alternative plans will negatively affect their sense of security within their own community.

The benefits and risks of the alternative plans should be equally shared.

Trace Element Emissions
(Basis: 500 MW 100% MCR 170 Mg Coal/h)

Element		Emission Factor* g/Mg Coal	Emission Rate g/h
Antimony	Sb	0.03	5.1
Arsenic	As	0.52	88.4
Barium	Ba	1.80	306.0
Berylium	Be	0.01	1.7
Boron	B	1.90	323.0
Bromine	Br	13.42	2281.4
Cadmium	Cd	0.02	3.4
Chromium	Cr	0.30	51.0
Cobalt	Co	0.07	11.9
Copper	Cu	0.15	25.5
Flourine	F	61.07	10381.9
Iron	Fe	51.06	8680.2
Lead	Pb	0.25	42.5
Manganese	Mn	0.50	85.0
Mercury	Hg	0.32	54.4
Nickel	Ni	0.30	51.0
Selenium	Se	0.59	100.3
Silver	Ag	0.02	3.4
Titanium	Ti	22.03	3745.1
Vanadium	V	0.30	51.0
Zinc	Zn	1.00	170.0
Thorium	Th	0.01	1.7
Uranium	U	0.008	1.32
Total		155.678	26465.22

* *Emission factors derived from Ontario Hydro research studies*

APPENDIX B – ALTERNATIVE PLANS – COMMON ELEMENTS

Common Components

Each of the three Demand/Supply Plans is designed to attain the maximum economic contribution from the common components. The contributions of the common components are presented below.

Demand Management Plan

- Electrical Efficiency Improvements adopted over the planning period reduce peak power and energy requirements by the amounts shown in Table B–1.
- Load Shifting programs adopted over the planning period reduce peak power requirements by the amounts shown in Table B–2. Load shifting does not reduce energy requirements.
- Capacity Interruptible Loads reduce peak power requirements by the amounts shown in Table B–3. Interruptible loads do not reduce energy requirements.
- The total impact of demand management is shown in Table B–4

Non-Utility Generation Plan

- Demand Displacement NUGs reduce peak power and energy requirements by the amounts shown in Table B–5.
- Purchase NUGs adopted over the planning period increase supply capacity and energy by the amounts shown in Table B–6.
- The total Non-Utility Generation contribution over the planning period in terms of net installed capacity and annual energy is shown in Table B–7.

Rehabilitation Plan

- The Rehabilitation Plan involves programs to rehabilitate hydraulic, fossil and nuclear facilities to ensure maximum use is made of existing facilities. The Rehabilitation Plan will include work on more than 20 GW of existing generating facilities over the plan period.
- The main elements of the plan are:

Hydraulic

- Small Hydro Assessment & Retrofit Program;
- Turbine Upgrade Program;
- Process Control Improvement Program;
- Dam Safety Assessment Program.

Fossil

- Acid Gas Reduction;
- Lakeview Rehabilitation;
- Lambton Rehabilitation;
- Other Fossil Station Rehabilitation.

Electrical Efficiency Improvements

Year End	Load Forecast Lower	Median	Upper
2000	1600	2000	2500
2014	2475	3400	4250

Annual Energy Reduction (TWh)

Year End	Load Forecast Lower	Median	Upper
2000	8.0	10.0	12.5
2014	12.4	17.0	21.2

Load Shifting

Year End	Load Forecast Lower	Median	Upper
2000	800	1000	1200
2014	1080	1280	1480

Capacity Interruptible Loads

Year End	Load Forecast Lower	Median	Upper
1988*	763	763	763
2000	599	702	798
2014	771	890	976

*actual

Total Demand Management Demand Reduction *

Year End	Load Forecast Lower	Median	Upper
1988	763	763	763
2000	2999	3702	4498
2014	4326	5570	6706

*Includes 763 MW of Capacity Interruptible Loads in effect in December 1988

Annual Energy Reduction (TWh)

Year End	Load Forecast Lower	Median	Upper
2000	8.0	10.0	12.5
2014	12.4	17.0	21.2

Demand Displacement Non Utility Generation

Year End	Load Forecast Lower	Median	Upper
2000	342	403	472
2014	382	456	522

Annual Energy Reduction (TWh)

Year	Load Forecast Lower	Median	Upper
2000	2.7	3.0	3.7
2014	3.0	3.4	4.1

Nuclear

- Fuel Channel Rehabilitation;
- Nuclear Plant Life Assurance;
- Pickering Output Increase.

Manitoba Purchase

- All plans include a firm purchase of 1000 MW from Manitoba, beginning in 1998. It provides energy and capacity as shown in Table B–8.

Hydraulic Plan

The Hydraulic Plan includes redevelopments, extensions or new developments (Table B–9) In terms of capacity, the Hydraulic Plan provides:

- 1209 MW by the end of year 2000; and
- 2849 MW by 2014.

In terms of energy, the Hydraulic Plan provides:

- 3.0 TWh of energy in 2000; and
- 5.8 TWh of energy in 2014.

The Hydraulic Plan is the same under all forecast.

Purchase Non-Utility Generation

Year End	Load Forecast Lower	Median	Upper
2000	435	932	1133
2014	864	1522	1660

*Net of NUG retirements

Annual Energy (TWh)

Year End	Load Forecast Lower	Median	Upper
2000	3.0	6.4	7.6
2014	5.8	10.3	11.2

Total Non-Utility Generation

Year End	Load Forecast Lower	Median	Upper
2000	797	1358	1632
2014	1268	2004	2212

Annual Energy (TWh)

Year End	Load Forecast Lower	Median	Upper
2000	5.7	9.4	11.3
2014	8.8	13.7	15.3

Table B – 8 Manitoba Purchase

Period (Nov 1 – Oct 31)	Capacity (MW)	Annual Energy (TWh)
1998 – 2000	200	1.4
2000 – 2001	400	3.0
2001 – 2002	600	4.7
2002 – 2003	1000	6.8
2003 – 2018	1000	7.0
2018 – 2020	800	5.6
2020 – 2021	600	4.2
2021 – 2022	400	2.8

Hydraulic Plan

Site	Developement Type	Incremental Installed Capacity (MW)	Annual Energy (AV.MW)	Flooding Required (ha)
Lake Gibson	New	5	5	Nil
Big Chute	Red	10	7	Nil
Mattagami Complex				
Kipling	Ext	68	11	Nil
Smoky Falls	Red	182	58	35
Harmon	Ext	68	11	Nil
Little Long	Ext	61	8	Nil
Four Sites Combined		379	87	35
Little Jackfish	New	132	65	2571
Queenston (SAB–3)	Ext	550	165	Nil
Abitibi Complex				
Abitibi Canyon	Ext	463	13	Nil
Otter Rapids	Ext	174	5	Nil
Nine Mile Rapids	New	295	83	473
Three Sites Combined		932	101	473
Renison	New	275	131	440
Grey Goose Island				326
Ragged Chute	Red	98	20	245
Patten Post	New	250	43	4082
Blacksmith Rapids	New	140	42	801
Sand & Allen Rapids	New	262	80	0

New = New Development
Ext = Extension to existing site
Red = Redevelopement of existing site

APPENDIX C – SUMMARY OF TYPICAL ENVIRONMENTAL EFFECTS AND MITIGATION

Table C-1: Pulp Cogeneration Steam Cycle - CSC

Component	Potential Effects	Potential Mitigation
NATURAL ENVIRONMENT		
Resource Use:		
Fuel	Coal - non-renewable - plentiful supply (short to medium term). - supplied from: Sask.; Alta.; B.C.; Penn., and; W.Va..	- use lower sulphur coal.
Land Use	- coal mining	- mine site rehabilitation
	- waste disposal (coal ash and scrubber wastes)	- recycle/re-use wastes (i.e. scrubber wastes for gypsum board production or other useful by-product).
	- generating station site.	- use of existing site.
	- transmission incorporation.	- use existing Right-Of-Way where possible.
Water Use	- cooling water intake/discharge effects - evaporative losses (consumptive use) less than 1% of cooling water flows.	- Intake: fish diversions, fish screens, offshore sub merged intake. - Discharge: tempering, offshore submerged discharge, monitoring of discharge temperature, cooling towers, use of expended thermal energy for more productive purposes (i.e. heat for aquaculture).
Emissions/Effluents/Waste:		
Air	Combustion Emissions:	
	- Boiler Combustion Emissions	
	- sulphur dioxide.	- fuel selection, scrubbers, coal washing.
	- nitrogen oxides	- boiler design and operation: low excess air, minimize combustion temperatures, urea injection, selective catalytic reduction (SCR)
	- particulates	- fuel selection (low ash); electrostatic precipitators; bag houses; gravity settling chambers in ducts.
	- trace elements	- fuel selection.
	- carbon dioxide	- fuel selection

Component	Potential Effects	Potential Mitigation
	- Combustion Turbine Emissions (SO_2, NO_x, particulate) from coal extraction and transport.	- fuel selection; stack and diffuser; high exhaust temperature and velocity; minimal operation.
	- Adverse dispersion conditions	- possible supplementary control measures: fuel switching or load
	Non-Combustion Emissions:	
	- Fuel transport, handling, and storage emissions (fugitive coal dust).	- dust control during rail transport and unloading; shielded or enclosed conveyors; surface wetting of coal piles; coal pile design/contouring.
	- Ash handling, transport and storage (fugitive dust).	- closed transfer of flyash from precipitators to silos; dust suppression at silo discharge for truck or conveyor transport to disposal site; regular covering and possible landscaping at disposal site; buffer areas.
Water	- inadvertent discharges or spills.	- provide collection and containment facilities for storage and handling of hazardous materials where appropriate; contingency plans for recovery and environmental protection.
	- coal pile drainage.	- treatment (neutralization).
	- ash pile drainage.	- collection and treatment; re-use / recycle.
Waste	- fly ash and bottom ash.	- re-use/recycle (i.e. cement additive, backfill, pit and quarry rehabilitation).
		- approved ash disposal site, lined with impermeable material for ground water protection (if required); drainage to liquid waste management system; regular compaction and covering.
	- screenhouse wastes.	- waste disposal site.
	- sludge materials from water and effluent treatment facilities.	- waste disposal site; possibly to ash disposal site for dust control.
	- operation trash, refuse and garbage.	- waste disposal site; possibly controlled incineration.
	- scrubber wastes.	- re-use/recycle (i.e. production of wallboard quality gypsum, use in cement, backfill, etc.).
	- PCB wastes from old/existing transformer sites/facilities.	- approved handling and storage.

Component	Potential Effects	Potential Mitigation
SOCIO-ECONOMIC ENVIRONMENT		
Employment	- significant employment contribution, direct and indirect. - local hiring higher in south, in proximity to major centres. - northern projects would require influx of project workers.	- initiatives to increase local-regional hiring (e.g. training, apprenticeship programs).
Regional Development	- significant effect, particularly in north or less developed regions.	- initiatives for local participation and benefits.

Local Community Impact	- depends on size, capacity, infrastructure or existing community.
	- also depends on proximity to major centres, past experience with development, compatibility with existing industry.
	- moderate impacts for existing sites with infrastructure, labour force.
	- potentially high level for new, remote or northern site.
	- potential impacts on:
	  - community infrastructure and facilities,
	  - community services,
	  - administration and finance,
	  - recreation and tourism,
	  - transportation facilities and services.
		- community impact monitoring.
		- community impact agreements for mitigation, grants, etc...
		- community liaison.
		- ash utilization.

Special / Sensitive Interests	- concerns re air quality, acid and greenhouse gases - environment, health,recreation, agriculture, forestry, historical preservation interests.	- meet or better emission regulations. - acid gas control technology. - information programs. - monitoring programs.
Lifestyle	- coal, ash and FGD waste-handling may affect character of area. - concerns re emissions may affect lifestyles. - influx of project workers may affect community character.	- acid gas control technology. - construction camp for remote or northern site.
Distribution of Risks & Benefits	- local effects of operations and emissions may be regarded as inequitable.	- enhancement of local benefits. - liaison and information.
Social Acceptance	- coal is least preferred among major supply options.	- information/education programs on role of fossil generation.

Component	Potential Effects	Potential Mitigation
NATURAL ENVIRONMENT		
Resource Use:		
Fuel	Coal - non-renewable - potential short to medium term supply. - supplied from: Sask.; Alta.; B.C.; Penn., and; W.Va.	- trend to lower sulphur coal.
Land Use	- coal mining - waste disposal - generating station site. - transmission incorporation.	- mine site rehabilitation - recycle/re-use wastes - use of existing site. - use existing Right-Of-Way where possible.
Water Use	- cooling water intake/discharge effects - evaporative losses (consumptive use) less than 1% of cooling water flows.	- Intake: fish diversions, fish screens, offshore submerged intake. - Discharge: tempering, offshore submerged discharge, monitoring of discharge temperature, cooling towers, use of expended thermal energy for more productive purposes (i.e. heat for aquaculture).
Emissions/Effluents/Waste:		
Air	Combustion Emissions: - Boiler Combustion Emissions: - sulphur dioxide - nitrogen oxides - trace elements - carbon dioxide - Combustion Turbine Emissions - Adverse dispersion conditions	- inherently low SO_2 emissions - little or no mitigation required. - boiler design and operation: low excess air, minimize combustion temperatures, urea injection, selective catalytic reduction (SCR). - fuel selection - fuel selection. - fuel selection; stack and diffuser; high exhaust temperature and velocity; minimal operation. - possible supplementary control measures: fuel switching or load reduction, if required.

Component	Potential Effects	Potential Mitigation
	Non-Combustion Emissions:	
	- Fuel transport, handling, and storage emissions (fugitive coal dust).	- dust control during rail transport and unloading; shielded or enclosed conveyors; surface wetting or coal piles; pile design/contouring.
	- slag handling, transport and storage - fugitive dust	- regular covering and possible landscaping at disposal site; buffer zones.
Water	- inadvertent discharges or spills.	- provide collection and containment facilities for storage and handling of hazardous materials where appropriate; contingency plans for recovery and environmental protection.
	- coal pile drainage.	- treatment (neutralization).
	- slag pile drainage.	- collection and treatment; re-use / recycle.
Waste	- screenhouse wastes	waste disposal site.
	- sludge materials from water and effluent treatment facilities	waste disposal site; possibly to isposal site for dust control.
	- operation trash, refuse and garbage.	- waste disposal site; possibly controlled incineration.
	- slurry wastes.	- re-use/recycle.
SOCIO-ECONOMIC ENVIRONMENT		
Employment	- moderate due to smaller scale.	- initiatives to increase local and regional hiring on northern projects (e.g. training, apprenticeship programs).
	- modular or staged development may reduce peaks and extend employment over longer schedule.	
	- local hiring higher in south in proximity to major centres.	
	- northern project may require influx of project workers.	
Regional Development	- moderate due to smaller scale.	- initiatives for local hiring and economic benefit (e.g. local purchasing policies).
	- significance for new sites depends on size and location.	
	- more significant regional development for northern locations.	

Component	Potential Effects	Potential Mitigation
Local Community Impact	- limited for small projects at existing sites to significant for major new IGCC at new site. - potential impacts on: - community infrastructure and facilities. - community services. - administration and finance. - transportation facilities and services. - depends on size, capacity, infrastructure of local communities, - also depends on proximity to major centres, past experience with development, compatibility with existing industry. - modular or staged development may reduce pressure on community facilities.	- community impact monitoring. - impact management programs. - community impact agreements for major projects. - community liaison.
Special / Sensitive Interests	- concerns about air quality and emissions among environmental, health, recreation, agriculture, forestry and historical preservation interests.	- meet or better emission regulations. - monitoring programs. - information programs.
Lifestyle	- limited for small facilities on existing sites. - may be significant for major IGCC projects on new sites.	- impact management programs. - emergency preparedness programs.
Distribution of Risks & Benefits	- local effects of operations (emissions and coal handling) may be considered inequitable.	- enhancement of local benefits. - community liaison.
Social Acceptance	- natural gas preferred among major supply options.	- N/A

(CANDU)

Component	Potential Effects	Potential Mitigation
NATURAL ENVIRONMENT		
Resource Use:		
Fuel	Uranium: - non-renewable. - plentiful supply (approx. 442,000 tonnes in Canada). - indigenous supply in Ontario, also supplied from Sask.	
Land Use	- uranium mining - tailings disposal	- mine site rehabilitation. - disposal at mine site with underwater containment of tailings. - 2 km buffer zone around tailing disposal sites.
	- generating site development. - used fuel and low level radwaste storage/disposal.	- 1 km exclusion zone (regulated by AECB); use of existing site. - on-site storage - long-term disposal site for used fuel being sought (concept assessment in progress).
	- transmission incorporation.	- use existing Right-Of-Way where possible.
Water Use	- cooling water intake/discharge effects - evaporative losses (consumptive use) less than 1% of cooling water flows.	- Intake: fish diversions, fish screens, offshore sub merged intake. - Discharge: tempering, offshore submerged discharge, monitoring of discharge temperature, cooling towers, use of expended thermal energy for more productive purposes (i.e. heat for aquaculture).
Emissions/Effluents/Waste:		
Air	- Potential Radioactive Releases Typical emissions include: - tritium - noble gases - Iodine (I_{131}) - particulates	- 1 km exclusion zone around reactors required by AECB. - 1% derived emission limit (DEL) operating target (As Low As Reasonably Achievable - ALARA).
	- hydrogen sulphide (H_2S) - heavy water production.	- flaring, population density restrictions out to 8km.
	- reactor building and reactor auxiliary bay exhausts (incl. off-gas systems).	- incremental operation of BNPD Heavy Water Plant - continuous filtering and monitoring of stacks and exhaust.

Component	Potential Effects	Potential Mitigation
	- service building exhausts (incl. used (irradiated) fuel bay).	- continuous filtering of contaminated exhausts.
	- ancillary service bldg. exhausts (incl. radwaste management and D20 upgrading)	- continuous filtering.
	- releases during transportation of radioactive materials.	- stringent container design and shipment regulations.
	- postulated emergency conditions.	- Safety systems: - emergency reactor shutdown. - containment (incl. vacuum bldg.). - emergency preparedness planning (i.e. evacuation plans) regulated by Ontario Solicitor General.
	Non-Radioactive Emissions:	
	- combustion turbine emissions (SO_2, NO_x, particulate)	- fuel selection; stack and diffuser; high exhaust temperature and velocity; limited operation.
	Potential Radioactive Releases:	
	- tritium	- 1% DEL operating target (ALARA). - tritium removal facility (TRF) at Darlington site.
Water	Non-Radioactive Releases:	
	- inadvertent discharges or spills.	- provide collection and containment facilities for storage and handling of hazardous materials where appropriate; contingency plans for recovery and environmental protection.
	- interface between radioactive and non-radioactive systems.	- periodic sampling of secondary system for radioactivity and D20 leakage; in-line leak detection monitors at major D20 / H20 interfaces.
Waste	Radioactive Solid Materials:	
	- used/irradiated fuel	- irradiated fuel management plan - long term disposal concept under review by AECL. - on-site storage.
	- low and medium level wastes	- waste management plan. - low level radioactive waste storage at BNPD regulated by AECB.
	Non-Radioactive wastes:	
	- screenhouse wastes	- approved waste disposal sites.
	- sludge materials	- approved handling and storage.
	- operation trash, refuse and garbage.	
	- CFC's in dry cleaning area.	- CFC phase out

Table C-3: Nuclear (CANDU) [illegible]

Component	Potential Effects	Potential Mitigation
SOCIO-ECONOMIC ENVIRONMENT		
Employment	- major employment contribution, direct and indirect. - local hiring higher in south, in proximity to major centres. - northern projects will require influx of project and indirect workers.	- initiatives to increase local and regional hiring (e.g. training and apprenticeship programs).
Regional Development	- major effect, particularly in north or less developed region - opportunity for heat-energy project.	- initiatives for local participation and benefits (e.g. local purchase policies).
Local Community Impact	- depends on size, capacity, infrastructure of local communities. - also depends on proximity to major centres, past experience with development, compatibility with existing industry. - impacts moderate for existing sites with infrastructure, labour force. - impacts potentially significant for sites in less developed areas. - potential impacts on: · community infrastructure and facilities · community services · administration and finance · recreation and tourism · transportation facilities and services	- community impact monitoring. - community impact agreements for mitigation, grants, etc.. - community liaison. - construction camp for remote or northern sites.
Special / Sensitive Interests	- emission, waste management and safety concerns for environment, community, health and safety, recreation interests. - Native, environmental, recreation interests for northern sites.	- information programs. - monitoring programs. - emergency preparedness.
Lifestyle	- perceived health and safety risks may affect lifestyle and perception of community. - large influx of project workers may change character of surrounding communities.	- local programs for liaison and information. - impact management programs to reduce adverse impacts. - emergency preparedness programs. - health monitoring studies.
Distribution of Risks & Benefits	- potential perception of inequitable risk for residents in vicinity of facilities. - concerns re effects of waste management on future generations.	- enhance local benefits. - liaison and information. - commitment to waste disposal program.
Social Acceptance	- among supply options, less preferred than gas, more than coal	- information/education on role of nuclear power generation.

Component	Potential Effects	Potential Mitigation
NATURAL ENVIRONMENT		
Resource Use:		
Fuel	- Natural Gas / Oil - short - medium term supply. - non-renewable	
Land Use	- large land-use involved in gas and petroleum extraction/refinement. - generating site. - transmission incorporation. - pipeline Right-of-Way.	 - use existing generating site. - use existing Right-of-Way where possible. - use existing Right-of-Way where possible.
Emissions/Effluents/Waste:		
Air	Combustion Emissions: - sulphur dioxide - nitrogen oxides.	 - fuel selection (low sulphur). - boiler design and operation; low excess air, minimize combustion temperatures, urea injection, selective catalytic reduction (SCR).
	- carbon monoxide. - trace elements. - carbon dioxide. - Adverse dispersion conditions.	 - fuel selection - fuel selection (gas preferred). - possible supplementary control measures; fuel switching or load reduction, if required.
	Non-Combustion Emissions: - high NO_x release from pump compressors. - fuel transport, handling and storage emissions (oil vapour).	 - special rail cars or possibly pipeline delivery; closed storage tanks.
Water	- inadvertent discharges or spills.	- dykes around hazardous materials storage facilities. - provide collection and containment facilities for storage and handling of hazardous materials where appropriate; contingency plans for recovery and environmental protection.

Component	Potential Effects	Potential Mitigation
Waste	- disposal of operation fluids (i.e. lubricants coolants).	- separate collection and drainage systems.
	- screenhouse wastes.	- waste disposal site.
	- sludge materials from water and effluent treatment facilities.	- waste disposal site; possibly to ash disposal site for dust control.
	- operation trash, refuse and garbage.	- waste disposal site; possibly controlled incineration.
	- PCB wastes from old/existing transformer sites/facilities.	- approved handling and storage.
SOCIO-ECONOMIC ENVIRONMENT		
Employment	- limited due to smaller scale	- initiatives for local hiring (e.g. training).
	- modular or staged development may reduce peaks and extend employment over longer schedule.	
Regional Development	- limited to moderate due to smaller scale	- initiatives for local economic benefit (e.g. local purchasing policies).
	- significance for new sites depends on size and location.	
Local Community Impact	- limited for small projects at existing sites to	- community impact monitoring.
	significant for major new CC at new site.	- impact management programs.
	- potential impacts on:	- community act agreements for major projects.
	- community infrastructure and facilities.	- community liaison.
	- community services.	
	- administration and finance.	
	- transportation facilities and services.	
	- depends on size, capacity, infrastructure of local community.	
	- also depends on proximity to major centres, past experience with development, compatiblity with existing industry.	
	- modular or staged development may reduce pressure on community facilities.	
Special / Sensitive Interests	- concerns about air quality and emissions among environmental, health, recreation, agriculture, forestry and historical preservation interests.	- meet or better emission regulations. - monitoring programs. - information programs.
Lifestyle	- limited for small facilities on existing sites.	- impact management programs.
	- may be significant for major projects on new sites.	- emergency preparedness programs.
Distribution of Risks & Benefits	- local effects of operations may be considered inequitable.	- enhancement of local benefits. - community liaison
Social Acceptance	- natural gas preferred among major supply options.	- N/A

Component	Potential Effects	Potential Mitigation
NATURAL ENVIRONMENT		
Resource Use:		
Fuel	- refined fossil fuels (oil, gas, diesel fuel). - non-renewable - short - medium term supply.	
Land Use	- large land-use involved in gas and petroleum extraction/refinement.	
	- generating site.	- use existing fossil generating station sites where possible.
	- pipeline Right-of-Way	- use existing Right-of-Way where possible.
	- transmission incorporation.	- use existing Right-of-Way where possible.
Water Use	- none	- air cooled
Emissions/Effluents/Wastes:		
Air	Combustion Emissions: - carbon monoxide - NO_x - CO_2	- NO_x controls. - fuel selection (gas preferred).
	Non-Combustion Emissions: - high SOx release during natural gas extraction. - high NOx release from pump compressors. - fuel transport, handling and storage emissions/losses.	- oil vapour: special rail cars or possibly pipeline delivery; closed storage tanks.
Water	- inadvertent spills.	- dykes around fuel storage facilities. - provide collection and containment facilities for storage and handling of hazardous materials where appropriate; contingency plans for recovery and environmental protection.
Waste	- disposal of operation fluids (i.e. lubricants, coolants) - operation trash, refuse, garbage. - PCB wastes from old/existing transformer sites/facilities.	- separate collection and drainage systems. - approved waste disposal site; controlled incineration. - approved handling and storage.

Component	Potential Effects	Potential Mitigation
SOCIO-ECONOMIC ENVIRONMENT		
Employment	- limited due to smaller scale. - little effect for CTU's at existing sites. - modular or staged development may reduce peaks and extend employment over longer schedule.	- none required.
Regional Development	- limited to moderate due to smaller scale - significance for new sites depends on size and location.	- initiatives for local hiring and economic benefit.

Local Community Impact	- limited for small projects at existing sites to significant for major CTU at new site.
	- potential impacts on:
	  - community infrastructure and facilities
	  - community services
	  - administration and finance
	- modular or staged development may reduce pressure on community facilities.
		- community impact monitoring.
		- impact management programs.
		- community impact agreements for major projects.
		- community liaison.

Special / Sensitive Interests	- concerns about air quality and emissions among environmental, health, recreation, agriculture, forestry and historical preservation interests	- meet or better emission regulations. - monitoring programs. - information programs.
Lifestyle	- limited for small facilities on existing sites. - may be significant for major projects on new sites	- impact management programs.
Distribution of Risks & Benefits	- local effects of operations may be considered inequitable.	- enhancement of local benefits. - community liaison.
Social Acceptance	- natural gas preferred among major supply options	- N/A

Component	Potential Effects	Potential Mitigation
NATURAL ENVIRONMENT		
Resource Use:		
Fuel	- water resources - renewable	- water rental payments to Ontario Government (approximately $90 M across the system in 1988).
Land Use	- generation site (including flooding to establish reservoirs).	- wildlife relocation, afforestation to replace flooded vegetation, resource extraction prior to flooding, compensation for flood loss, relocation of affected structures/land-uses, redevelop existing sites with existing reservoirs.
	- access roads.	- minimize clearing, use of existing roads, minimize road size.
	- aggregate supply.	- use of on-site material, restore borrow areas.
	- transmission incorporation.	- use existing Right-of-Way where possible.
Water Use	- non-consumptive (see Fuel).	
Emissions/Effluents/Wastes:		
Air	- local air quality deterioration (i.e. construction dust, slash/vegetation burning).	- controlled waste timber/vegetation burning, minimize site clearing, road spraying.
Water	- initial reservoir filling.	- slow consistent filling rate; winter filling.
	- altered flow regimes.	- channel modifications (i.e. widening, deepening), minimize head and modifications.
	- increased erosion.	minimize site clearing, bank stabilization (i.e. vegetation, rip-rap), channel modification, flow regulation, buffer zones along banks.
	- water quality effects.	- manage flow to minimize temporary flooding effects; reservoir preparation planning (i.e. vegetation clearing to minimize nutrient and methyl / mercury release); monitoring, erosion control, sediment control (i.e. settling ponds).

Component	Potential Effects	Potential Mitigation
	- destruction of aquatic habitat/fish stock degradation.	- timing of activities (i.e. avoid spawning periods); reservoir preparation plan for habitat protection; maintain instream flows; protect spawning areas; habitat enhancement; stocking headponds.
	- wetlands	- avoid wetlands, dyking.
Waste	- construction wastes (i.e. oils, fuel).	- dyke storage areas, emergency clean-up procedures.
	- operation trash, refuse and garbage.	- approved disposal sites.
	- headpond debris.	- reservoir clearing, reservoir sweeping.
	- excavation material.	- approved disposal area, utilize in dam construction where possible.
SOCIO-ECONOMIC ENVIRONMENT		
Employment	- significant but short term for individual sites.	- Hydro / trade union / government cooperation and initiatives for local hiring, training, qualifying for northern projects.
	- some indirect employment for individual sites.	
	- major significance for river basin development.	
	- major indirect employment for river basin development.	
Regional Development	- moderate regional development for individual sites.	- Hydro / government initiatives for local purchasing, local business development.
	- significant regional development for river basin.	
	- northern projects may provide electrification and access needed for development.	
Local Community Impact	- potentially significant impacts of in-moving population for northern, remote projects.	- construction camps for northern / remote sites.
	- potential impacts on:	- community impact agreements.
	- community infrastructure and facilities	- impact monitoring.
	- community services	- impact management programs.
	- administration and finance	
	- transportation facilities and services	
	- depends on size, capacity, infrastructure of local communities.	
	- also depends on proximity to population centres, past experience with development	
	- long-term effect for Moose River Basin on all aspects of communities.	

Component	Potential Effects	Potential Mitigation
Special / Sensitive Interests	- Native People: land claims, land use, lifestyle, employment, subsistence hunting and fishing. - cottagers, recreation, water users affected by flow or quality. - tourism for northern rivers, Niagara Development.	- negotiations / agreements on participation, mitigation. - operations controls, engineering to avoid adverse impacts. - scheduling of activities. - health monitoring where mercury a potential problem.
Lifestyle	- change in northern lifestyles, particularly for Native People.	- construction camps. - initiatives for local participation in project.
Distribution of Risks & Benefits	- northern and Native People may be inequitably affected unless opportunities to share in the benefits.	initiatives to ensure and enhance local and regional benefits.
Social Acceptance	- high preference for hydraulic among supply options. - high preference for rehabilitating / improving existing facilities.	- N/A

Component	Potential Effects	Potential Mitigation
NATURAL ENVIRONMENT		
Resource Use:		
Fuel	- electricity (derived from hydraulic generation) from Manitoba and/or Quebec. - renewable resource	
Land Use	- transmission incorporation. (will need additional transmission facilities for any project >750 MW in Quebec or >200 MW in Manitoba).	- use existing Right-of-Way where possible. - prudent Right-of-Way planning and routing process. - narrow-based towers to reduce land displacements in critical areas, bury lines in certain sensitive areas.
Emissions/Effluents/Wastes:		
Air	- electromagnetic field effects.	- wider Right-of-Way's, higher towers, reduce line voltage.
	- noise from transformers.	- larger buffer zones, screening, landscaping, site contouring. - improved sound enclosures.
Water	- potential impacts on nearby wells from construction activities. - herbicides for vegetation control.	- pre-construction water well monitoring and test programs. - pre and post-application water monitoring and test programs. - controlled use of herbicides / pesticides; cut vegetation mechanically; selective application (hand release); proper storage and disposal of containers.
	- sediment control.	- vegetation. sediment control, site contouring.
Waste	- construction wastes	- approved method of transport and disposal site.
Aesthetics	- towers and lines	- tower design (colour, shape), bury / screening

Component	Potential Effects	Potential Mitigation
SOCIO-ECONOMIC ENVIRONMENT		
Local Socio-Economic Effects		
Employment	- mainly in exporting province.	- N/A
Regional Development	- limited to effects of transmission construction.	- initiatives for local hiring and economic benefits on transmission.
Local Community Impact	- limited to transmission impacts in Ontario.	- transmission routing to avoid or reduce disruption and displacement.
	- may be significant in exporting provinces, particularly northern and native communities	- support appropriate mitigation by exporting province.
Societal Considerations		
Special / Sensitive Interests	- Native people affected in exporting province. - agriculture, recreation, resource interests affected by transmission. - labour and business concerns re transfer of employment and economic benefits.	- impact management programs by exporting province.
Lifestyle	little or no effect in Ontario - may be significant in areas affected by hydraulic projects in Manitoba or Quebec.	- support mitigation by exporting province.
Distribution of Risks & Benefits	- environmental and community impacts in other provinces may be considered inequitable	- encourage programs for local participation and impact management in exporting province.
Social Acceptance	- preference for hydraulic generation. - concerns about export of jobs, reliability.	- N/A

Component	Potential Effects	Potential Mitigation
NATURAL ENVIRONMENT		
Resource Use:		
Fuel	- reduces fuel consumption. - defers the need for development of additional supply. - affects fuel consumption pattern - allows more optimal use of cleaner resources.	
Land Use	- raw materials for building insulation.	
Emissions/Effluents/Wastes:		
Air	- potential degraded interior air quality (e.g. radon, formaldehyde, combustion by-products, CFCs).	- improved ventilation (air exchange) systems in residences and other buildings. - reduce the use of building materials which contain offending pollutants (e.g. asbestos)
Water	- N/A	
Waste	- disposal of phased out, less efficient appliances and equipment.	- disposal in an approved landfill site. - recycle parts, rehabilitate existing appliances and equipment (improve efficiency). - remove and store toxic constituents (e.g. PCB's, CFC's).
SOCIO-ECONOMIC ENVIRONMENT		
Employment	- high employment but dispersed regionally and among sectors.	- none required.
Regional Development	- little or none because of distributed nature.	- none required.
Local Community Impact	- little direct impact because distributed. - standards, building codes, etc., may affect pace and cost of housing development.	- incentives/savings may offset increased cost of energy-efficient housing.
Special / Sensitive Interests	- some groups may have less access to programs. - high energy costs could affect low income, industrial customers.	- range of programs.
Lifestyle	- time of use may affect energy-use pattern, including household activities, increased shift work. - high-efficiency equipment will have little or no effect.	- encourage use of timers and devices to shift load without inconvenience. - none required for increased efficiency.
Distribution of Risks & Benefits	- if unavailable or access difficult for some groups, may be inequitable costs and benefits.	- range of programs. - incentives to make accessible.
Social Acceptance	- high preference for voluntary programs with incentives.	- information/education on demand management practices.

Component	Potential Effects	Potential Mitigation
NATURAL ENVIRONMENT		
Resource Use:		
Fuel	- municipal solid wastes (household trash, plastics, organics, etc.).	
Land Use	- facility site	
	- refuse storage	- ensure high turn-over rates with minimal on-site storage requirements.
	- ash disposal	- recycle/re-use wastes.
	- transmission incorporation	- use existing Right-of-Way where possible.
Water Use	- cooling water intake/discharge effects.	- Intake: fish diversions, fish screens. Discharge: tempering, monitoring of discharge temperatures, use of expended thermal energy for other purposes (i.e. aquaculture).
Emissions/Effluents/Wastes:		
Air	- emissions and effluent concentrations and types dependent upon make-up of refuse material. May include: NOx; HCl; SOx; CO; hydrocarbons; organic acids; Cl; mercury gas; PCB's; dust; particulate matter.	- flue gas treatment
	- odour from waste storage pile.	- ensure high turn-over rates for stored refuse; high burning temperatures, containment, enclosure.
	- ash handling, transport and storage dust.	- closed transfer systems; dust suppression at silo discharge for truck or conveyor transport to disposal site; regular covering and possible landscaping at disposal site.
Water	- ash pile drainage.	- collection and treatment.
Waste	- fly and bottom ash.	- re-use/recycle (i.e. backfill, pit and quarry rehabilitation) – may be restricted due to the presence of toxic substances (e.g. dioxin).
		- approved ash disposal site, lined with impermeable material for ground water protection (if required); drainage to liquid waste management system; regular compaction and covering.

Component	Potential Effects	Potential Mitigation
SOCIO-ECONOMIC ENVIRONMENT		
Employment	- limited to moderate depending on scale.	- none required by Hydro.
Regional Development	- limited due to small scale.	- none required by Hydro.
Local Community Impact	- limited impact to infrastructure and services due to scale.	- provincial regulations on operations.
	- municipal waste-burning may cause concerns about traffic, noise, odour.	- provincial requirements for environmental review of private projects. - impact management by generator.
Special / Sensitive Interests	- air quality and emissions effects of fossil and waste-burning of concern to environmental community, health and safety interests.	- provincial licensing and approval requirements for generation.
Lifestyle	- affect perception of community and concern re: health may affect lifestyle.	- technology to control emissions. - information programs, community liaison by generator.
Distribution of Risks & Benefits	- most costs and benefits localized. - may be equity concerns re: waste-burning.	- impact management by generator for waste-burning.
Social Acceptance	- strong customer preference for NUG, particularly small hydraulic and cogeneration. - lower social acceptance for Municipal Solid Waste. Potential for greater social acceptance if viewed as a feasible waste management solution as well	- N/A

Component	Potential Effects	Potential Mitigation
NATURAL ENVIRONMENT		
Resource Use:		
Fuel	- water resources - renewable	
Land Use	- generation site including flooding to establish reservoirs (if required)	- wildlife relocation, afforestation to replace flooded vegetation, resource extraction prior to flooding, compensation for flood loss, relocation of affected structures/land-uses — operate as run-of-river facility, redevelop existing sites where possible.
	- access roads	- minimize clearing, use of existing roads, minimize road size.
	- aggregate supply	- use of on-site material, restore borrow areas.
	- transmission incorporation	- use existing Right-of-Way where possible.
Water Use	- non-consumptive (see Fuel)	
Emissions/Effluents/Wastes:		
Air	- local air quality deterioration (i.e. construction dust, slash/vegetation burning).	- controlled waste timber/vegetation burning, minimize site clearing, road spraying.
Water	- initial reservoir filling (if required – usually run-of-river operation).	- slow consistent filling rate; winter filling, use existing dams and headponds.
	- altered flow regimes.	- channel modifications (i.e. widening, deepening), minimize head and modifications, operate as run-of-river vs. peaking plant.
	- increased erosion.	- minimize site clearing, bank stabilization (i.e. vegetation, rip-rap), channel modification, flow regulation, buffer zones along banks.
	- water quality effects.	- manage flow to minimize temporary flooding effects; reservoir preparation planning (i.e. vegetation clearing to minimize nutrient and methyl / mercury release); monitoring, erosion control, sediment control (i.e. settling ponds).
	- destruction of aquatic habitat/fish stock degradation.	- timing of activities (i.e. avoid spawning periods); reservoir preparation plan for habitat protection; maintain minimum instream flows; protect spawning areas; habitat enhancement; stocking headponds.
	- wetlands	- avoid wetlands, dyking.

Component	Potential Effects	Potential Mitigation
Waste	- construction wastes (i.e. oils, fuel) - operation trash, refuse and garbage. - headpond debris. - excavation material.	- dyke storage areas, emergency clean-up procedures. - approved disposal sites. - reservoir clearing, reservoir sweeping. - approved disposal area, utilize in dam construction where possible.
SOCIO-ECONOMIC ENVIRONMENT		
Employment	- limited due to small scale.	- none required by Hydro.
Regional Development	- limited due to small scale.	- none required by Hydro.
Local Community Impact	- limited due to scale - small hydro may affect recreational users.	- operations requirements. - requirements for environmental review of private projects.
Special / Sensitive Interests	- change in quality or quantity of water of concern to environmental, recreational interests.	- licensing and approval requirements for generation. - possible conditions for Hydro purchases of power.
Lifestyle	- little or no impact for most technologies.	- technology to control emissions.
Distribution of Risks & Benefits	- low potential for inequity for most technologies. - most costs and benefits localized.	- impact management by generator
Social Acceptance	- strong social acceptance for NUG, particularly small hydraulic and cogeneration.	- N/A

Component	Potential Effects	Potential Mitigation
NATURAL ENVIRONMENT		
Resource Use:		
Fuel	- Natural Gas	
Land Use	- large land-use involved in natural gas and petroleum extraction/refinement.	
	- generating site.	- use existing industrial site where possible.
	- pipeline Right-of-Way	- use existing Right-of-Way where possible.
	- transmission incorporation.	- use existing Right-of-Way where possible.
Water Use	- N/A	- air-cooled CTUs
Emissions/Effulents/Wastes:		
Air	Combustion Emissions:	
	- carbon monoxide	
	- NO_x and CO_2	- NO_x controls.
	Non-Combustion Emissions:	
	- high NO_x release from pump compressors.	
	- fuel transport, handling and storage emissions/losses.	- pipeline delivery.
Water	- inadvertent spills.	- dykes around hazardous materials storage facilities. - provide collection and containment facilities for storage and handling of hazardous materials where appropriate; contingency plans for recovery and environmental protection.
Waste	- disposal of operation fluids (i.e. lubricants, coolants)	- separate collection and drainage systems.
	- operation trash, refuse, garbage.	- approved waste disposal site; controlled incineration.

Component	Potential Effects	Potential Mitigation
SOCIO-ECONOMIC ENVIRONMENT		
Employment	- limited due to small scale.	- none required by Hydro.
Regional Development	- limited due to small scale.	- none required by Hydro.
Local Community Impact	- limited due to scale.	- provincial operations requirements. - provincial requirements for environmental review of private projects.
Special / Sensitive Interests	- air quality and emissions effects of fossil and waste-burning of concern to environmental community, health and safety interests.	- provincial licensing and approval requirements for generation.
Lifestyle	- little or no impact for most technologies.	- technology to control emissions.
Distribution of Risks & Benefits	- low potential for inequity for most technologies. - most costs and benefits localized.	- impact management by generator.
Social Acceptance	- strong social acceptance for NUG, particularly small hydraulic and cogeneration.	- N/A

Component	Potential Effects	Potential Mitigation
NATURAL ENVIRONMENT		
Resource Use:		
Fuel	- wood waste.	
Land Use	- generating site.	- use of existing kiln site where possible.
	- transmission incorporation.	- use existing Right-of-Way where possible.
Water Use	- cooling water intake/discharge effects.	- Intake and Discharge design
Emissions/Effluents/Wastes:		
Air	Combustion Emissions:	
	- carbon monoxide	
	- NO_x	- NO_x controls.
	- CO_2	
	- particulates	- electrostatic precipitators or fabric filters
Water	- inadvertent spills.	- dykes around hazardous materials storage facilities.
		- provide collection and containment facilities for storage and handling of hazardous materials where appropriate; contingency plans for recovery and environmental protection.
Waste	- disposal of operation fluids (i.e. lubricants, coolants)	- separate collection and drainage systems.
	- operation trash, refuse, garbage.	- approved waste disposal site; controlled incineration.
	- ash	- approved waste disposal site.
SOCIO-ECONOMIC ENVIRONMENT		
Employment	- limited due to small scale.	- none required by Hydro.
	- may be significant in northern community.	
Regional Development	- limited due to small scale but may be significant in northern community.	- none required by Hydro.
	- potential indirect effect if energy cost saving makes industry more competitive.	
Local Community Impact	- limited due to scale.	- provincial operations requirements.
	- may cause concerns about traffic, noise, odour.	- provincial requirements for environmental review of private projects.
Special / Sensitive Interests	- air quality and emissions effects of waste-burning of concern to environmental, community, health and safety interests.	- licensing and approval requirements for generation.
		- possible conditions for Hydro purchases of power.
Lifestyle	- little or no impact for most technologies.	- technology to control emissions.
Distribution of Risks & Benefits	- low potential for inequity for most technologies.	- impact management by generator.
	- most costs and benefits localized.	
Social Acceptance	- strong social acceptance for NUG, particularly small hydraulic and cogeneration.	- N/A